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# PHYSICS ABSTRACTS

Published by The Institution of Electrical Engineers

SECTION A OF SCIENCE ABSTRACTS

Edited and issued by THE INSTITUTION OF ELECTRICAL ENGINEERS, Savoy Place, London, W.C.2 © 1959

Published monthly in association with THE PHYSICAL SOCIETY, THE INSTITUTE OF PHYSICS, THE AMERICAN PHYSICAL SOCIETY, AND THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

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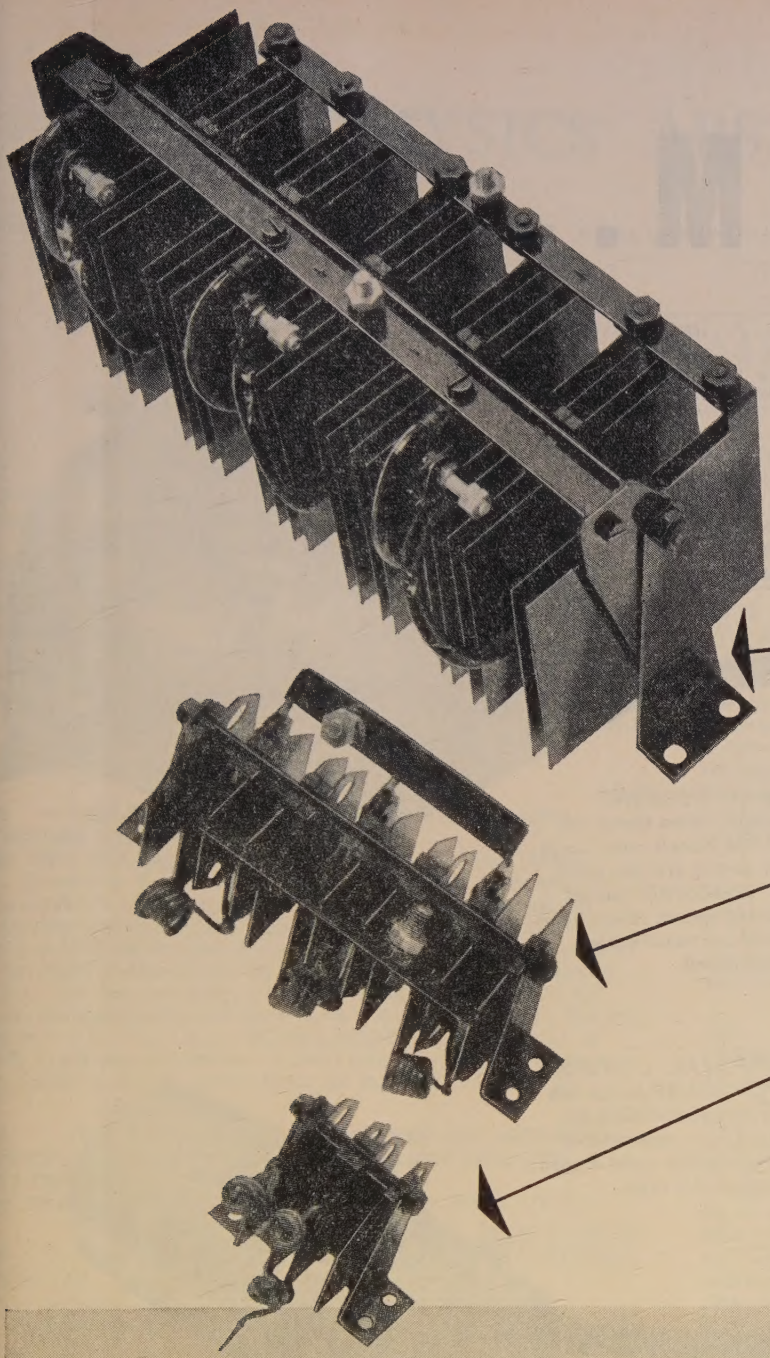

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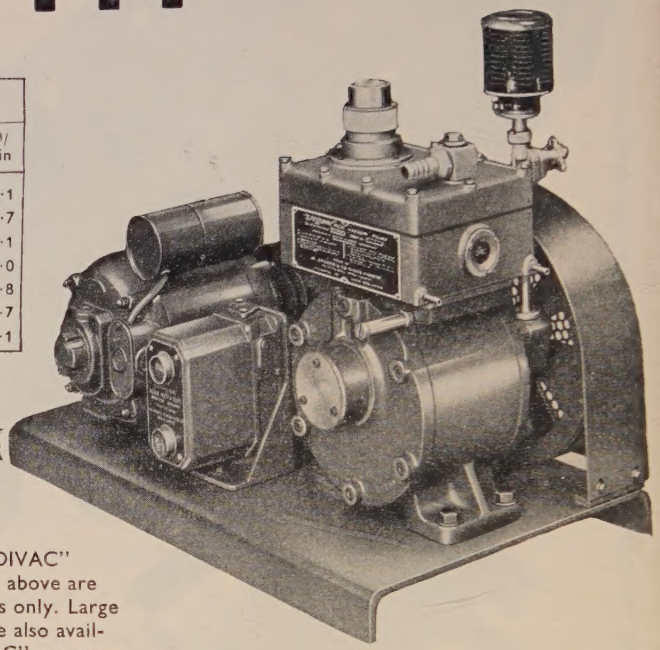

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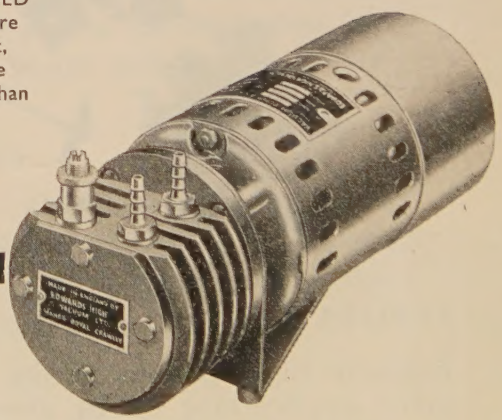

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# PHYSICS ABSTRACTS

Volume 62 FEBRUARY 1959 Number 734


## MATHEMATICS

517.2 : 530.145

977. META-DERIVATIVES AND ANTICOMMUTATORS. H.Freistadt and R.R.Struik.
Amer. J. Phys., Vol. 26, No. 7, 461-3 (Oct., 1958).

A functional operation (called meta-differentiation), suitable for representing quantum-mechanical momenta in terms of the coordinates to which they are conjugate, is constructed explicitly from the commutation or anticommutation relations. In the case of commutation relations, one is led to a slight generalization of the conventional derivative. The operation to be used in the case of anticommutation relations is to take the odd part of the function and divide by the independent variable.

517.94 : 539.17

SOLUTION OF $\nabla^2\Phi + B^2\Phi = 0$ IN ELEVEN COORDINATE SYSTEMS. See Abstr. 710

518.2

978. TABLES OF THE EXPONENTIAL INTEGRAL FOR COMPLEX ARGUMENTS.
App. Math. Ser. Nat. Bur. Stand., No. 51, xiv + 634 pp. (1958).

Devoted to the exponential integral $E_1(z)$, and to closely related functions, for arguments $z = x + iy$. The main portion of the publication tabulates $E_1(z)$ over the region $0 \leq x \leq 4$, $0 \leq y \leq 10$ to six decimal places. Also provided is a table of $E_1(z)$ to ten decimal places over the range $0 \leq -x$, $y \leq 3.1$ at intervals of 0.1. The function $E_1(z) + \log_e z$ is tabulated for $0 \leq x$, $y \leq 1$ to six decimal places, and for $0 \leq -x$, $y \leq 1$ to ten places. For the region $4 \leq x \leq 10$, $0 \leq y \leq 10$, the auxiliary function $e^x E_1(z)$ is given to six decimal places. A short table of $e^z E_1(z)$ is given to six places at varying intervals for the region $0 \leq \pm x$, $y \leq 20$.

518.2

979. TABLE OF NATURAL LOGARITHMS FOR ARGUMENTS BETWEEN FIVE AND TEN [AT INTERVALS OF 0.0001] TO SIXTEEN DECIMAL PLACES.
App. Math. Ser. Nat. Bur. Stand., No. 53, xiii+ 506 pp. (1958).

518.5 : 517.512

980. A CALCULATOR FOR NUMERICAL FOURIER SYNTHESIS. V.Timbrell.
J. sci. Instrum., Vol. 35, No. 9, 313-18 (Sept., 1958).

The calculator makes the customary method of synthesis, using 3 figure tables, ten times faster, and the accuracy is about the same. It is especially useful for the occasional synthesis that does not justify an automatic machine. For each of twelve harmonics, expressed in the form $R_k \sin(\phi_k + R\theta)$, numerical values are obtained for $\theta = 0^0, 7\frac{1}{2}^0, 15^0, \ldots 352\frac{1}{2}^0$. These are recorded on a work-sheet and the sum

$\sum_{k=1}^{k=12} R_k \sin(\phi_k + k\theta)$ is got by simple addition for each value of $\theta$.

The principle is applicable to any values of k and any of the commonly used intervals of $\theta$. Full use is made of the frequent recurrence of values for some harmonics in order to minimize the number of readings that must be taken from the calculator. A mechanical Fourier synthesizer of simple construction for handling fifteen harmonics is also described. This instrument enables the synthesized waveform to be plotted directly.

518.5

981. COMPUTING PLATES. J. de Meulenaer.
J. sci. Instrum., Vol. 35, No. 10, 356 (Oct., 1958).

A simple appliance is described by the aid of which a number can be set mechanically on the keyboard of a desk calculator any number of times.

519.283 : 530.162

982. DISTRIBUTION PROBLEMS RELATED TO STATISTICAL PHYSICS. P.A.Pompéia.
An. Acad. Brasil. Cienc., Vol. 27, No. 2, 123-36 (1955).

Let N objects be distributed in M boxes so that there are $n_0$ boxes with no object, $n_1$ boxes with one object, etc. This paper is an elementary discussion concerning the probability distribution for the sets $(n_0, n_1, \ldots)$, given that each object is assigned to a box at random. The discussion centres on the values of $n_r$ corresponding to maximum probability. In particular, these values are found when there are certain limiting relations between N and M e.g. for $N > M^3$ (distinguishable objects) and for $N > \frac{1}{2}M(M-1)$ (indistinguishable objects). The physical applications are not made clear and there is a curious and highly individual "significance test" discussed at some length. R.O.Davies

## ASTROPHYSICS

523.03

983. THE GENERALIZATION OF THE EDDINGTON–BARBIER RELATIONS AND ITS APPLICATIONS. S.Dumont and J.C.Pecker.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 425-8 (July 28, 1958).
In French.

An iterative method is outlined, applicable to integral equations like that for intensity $I_\nu(\mu)$ in terms of the source functions $S_\nu(\tau)$. The case $S_\nu(\tau) = a + b\tau + c\exp(-k\tau)$ is considered in detail. The solutions do not converge. G.A.Chisnall

523.03 : 532.5 : 538.3

THE INSTABILITY OF A LAYER OF AN ELECTRICALLY CONDUCTING FLUID HEATED BELOW AND SUBJECT TO THE SIMULTANEOUS ACTION OF A MAGNETIC FIELD AND ROTATION (CORIOLIS ACCELERATION). See Abstr. 469

523.112

984. ON THE PROBLEM OF THE HUBBLE EFFECT. T.Neugebauer.
Acta phys. Hungar., Vol. 8, No. 4, 365-85 (1958). In German.

Further consideration is given to the possibility of explaining the effect in terms of neutrino scattering. Classical and relativistic scattering processes are considered, and it is concluded that a resultant energy loss does not necessarily imply an appreciable deflection of a light ray. R.A.Newing

523.152

985. ON THE TURBULENCE IN THE PROTOPLANETARY CLOUD. V.S.Safronov.
Rev. mod. Phys., Vol. 30, No. 3, 1023-4 (July, 1958).

A brief critical survey of theoretical ideas on this problem. O.Penrose

523.16

986. GAS DYNAMICS OF GALAXY COLLISIONS. M.P.Savedoff.
Rev. mod. Phys., Vol. 30, No. 3, 1074-5 (July, 1958).

When two galaxies collide at 1000 km/sec, one expects to find after $10^8$ sec a hot compressed gas bounded by two shock waves advancing into the two approaching gas streams. The shock relations are used to calculate the temperature and density of the compressed gas. Numerical estimates are given of how fast the region ionizes and approaches temperature equilibrium (both processes are rapid); also of the rate of cooling by radiation and of the importance of self-gravitation (both apparently small). The model may apply to the Cygnus A radio source. O.Penrose

523.16 : 532.5 : 538.3

987. POSSIBLE HYDROMAGNETIC SIMULATION OF COSMICAL PHENOMENA IN THE LABORATORY. W.H.Bostick.
Rev. mod. Phys., Vol. 30, No. 3, 1090-4 (July, 1958).

For perfect scaling, the laboratory magnetic fields should be $10^{12}$ larger and the conductivity $10^8$ larger than in these experiments. The author gives reasons for believing that it is nevertheless possible to simulate certain gross features of the galactic system by means of the "plasmoids" produced in these experiments. Photographs, reproduced from an earlier paper (Abstr. 6218/1957), illustrate several types of encounter between plasmoids. In a newly-forming galaxy, Rayleigh–Taylor instability may produce the large-scale analogue of a plasmoid — in fact, this could be a spiral arm. A magnetic-field and electric-current pattern is suggested which may lead to regenerative dynamo action in the galaxy. O.Penrose

523.161

988. ON THE FORMATION OF INTERSTELLAR GAS CLOUDS. S.A.Kaplan.
Rev. mod. Phys., Vol. 30, No. 3, 943 (July, 1958).

This paper outlines some results of a theory of shock waves accompanied by radiative energy loss. The increase of density across such shocks can be as large as 30 times. Behind the shock the velocity is nearly $\parallel$ to the shock front and to the magnetic field (if any). A method of "self-preserving solutions" (Abstr. 6807/1955) for studying shock and ionization front problems is mentioned. The author considers that a magnetic field makes turbulent eddies more isolated than they are in no field; interstellar gas clouds may be isolated eddies of such turbulence. O.Penrose

523.161

989. MAGNETOHYDRODYNAMIC DISSIPATION. L.Biermann and A.Schlüter.
Rev. mod. Phys., Vol. 30, No. 3, 975-7 (July, 1958).

Three mechanisms are discussed which can dissipate kinetic energy of interstellar gas into heat. (1) Ambipolar diffusion — the difference in velocity between neutral particles and ions in the presence of magnetic forces. The estimated dissipation rate is somewhat less than that of turbulence and viscosity in H I regions and insignificant in H II regions. (2) Acceleration of cosmic rays. This could be quite important. Assuming that the mean free path, not the gyration radius, determines shock-wave thickness, the Fermi mechanism can operate only in dense H II regions. (3) Redistribution of kinetic energy during periodic magnetic field variations. A periodically varying field will heat a gas if the frequency exceeds the collision frequency but not the gyration frequency. This mechanism may be important in the solar corona. O.Penrose

523.161

990. ON THE CONDENSATION OF INTERSTELLAR MATERIAL. E.Schatzman.
Rev. mod. Phys., Vol. 30, No. 3, 1012-13 (July, 1958).

A slab of interstellar matter illuminated on both sides can be in a steady state under the processes of ionization and recombination, absorption and re-emission. It is shown that such a slab will be in unstable pressure equilibrium if it is too thick. A dense H II cloud may satisfy the instability condition and collapse, ultimately forming neutral hydrogen. O.Penrose

523.161

991. ON THE PROPAGATION AND STRUCTURE OF IONIZATION FRONTS. F.A.Goldsworthy.
Rev. mod. Phys., Vol. 30, No. 3, 1062-6 (July, 1958).

Differential equations and surface conditions are set up describing the behaviour of initially neutral hydrogen near a star or line of stars. The author treats similarity solutions of these equations, in which the independent variables occur only in the combination $t/r$. The solutions for the density, temperature, velocity, and radiation flux are presented graphically for two situations with cylindrical symmetry. In one of these the ionization front is preceded by a shock and in the other it is not. The structure of a D-type ionization-cum-shock front is also described, by a graph giving the density, degree of ionization, temperature, and radiation flux. O.Penrose

523.161

992. GAS-DYNAMICAL EFFECTS OF STAR FORMATION. M.P.Savedoff.
Rev. mod. Phys., Vol. 30, No. 3, 1073-4 (July, 1958).

The author has already proposed a theory (Astrophys. J., Vol. 124, No. 3, 533, Nov. 1956 and Abstr. 5609/1956) of a spherical shock followed at some distance by an ionization front expanding into neutral hydrogen, leaving behind them an H II region. Some numerical data calculated from this model are tabulated here. They are compared with observational data on $\lambda$ Orionis and Barnard's loop. The theory is also used to estimate the overall input of energy from radiation into motion of the interstellar medium. O.Penrose

523.161 : 532.5 : 538.3

993. SHOCK WAVES IN MAGNETOGASODYNAMIC TURBULENCE S.A.Kaplan.
Rev. mod. Phys., Vol. 30, No. 3, 1089 (July, 1958).

Observational data on the spatial variation of velocities and magnetic fields in interstellar gas clouds are analysed and compared with the author's spectral theory of isotropic magnetogasodynamic turbulence (Abstr. 6807/1955). Agreement is good when the theoretical parameters refer to the case where shock-wave energy dissipation is unimportant. O.Penrose

523.164.32

994. RADIO OBSERVATIONS OF THE SOLAR ECLIPSE OF 30 JUNE 1954 ON 169 Mc/s. R.Coutrez.
Ann. Astrophys., Vol. 20, No. 1, 23-44 (1957). In French.

Results from three stations (one within the belt of totality) are used to plot the coronal brightness out to two solar radii from the disk. Its distribution is slightly asymmetric with maximum coronal intensity N of the centre (at heliographic coordinates, $L = 141^0$, $\phi = +16^0$); at the time of the eclipse there was a noticeably bright "plage" in $H_\alpha$ light at $L = 154^0$, $\phi = +32^0$. The bright ring over the disk, predicted from Cambridge interferometric observations on 1.4 m (1957), is not evident on isophotic plots of the eclipse results. D.R.Barber

523.164.4

995. EVIDENCE ON THE SPATIAL DISTRIBUTION OF RADIO SOURCES DERIVED FROM A SURVEY AT A FREQUENCY OF 159 Mc/s. D.O.Edge, P.A.G. Scheuer and J.R.Shakeshaft.
Monthly Nat. Roy. Astron. Soc., Vol. 118, No. 2, 183-96 (1958).

Some results from a survey of radio sources at 159 Mc/s are available for limited regions of the sky. These are discussed in relation to the spatial distribution of sources. A comparison of the individual sources shows that about one quarter of those in the previous survey at 81.5 Mc/s are confirmed, but that for the weaker ones the reliability is worse than was indicated in the list. A comparison between the new positions and those found by Mills and Slee (Abstr. 5803/1957) at 85 Mc/s indicates fair agreement for sources with flux densities more than $20 \times 10^{-26}\,\mathrm{Wm^{-2}(c/s)^{-1}}$ at 85 Mc/s, but poor agreement among the weaker sources. A simple plot of log N against log S, where N is the number of sources with flux density greater than S, gives a slope of $-2.2$ for one region and $-2.7$ for another, but these slopes may be affected to an unknown extent by confusion between nearby sources and by sources having finite angular diameters. A method of analysis depending on the statistical distribution of amplitudes on the records and independent of confusion errors shows that for the fainter sources the observations are consistent with a uniform distribution of sources. Between these and the intense sources a discrepancy in numbers remains. An argument may be devised to show that the 150 Mc/s observations, when taken together with previous results at 81.5 Mc/s are inconsistent with a uniform distribution. This result is, however based on data of which the statistical significance is not sufficiently great to be conclusive, and further observations are needed.

523.165 : 537.591.2

996. INTENSITY PROBLEM IN THE DEFLECTION OF COSMIC RAYS IN THE SOLAR MAGNETIC FIELD. T.Yagi.
J. Geomagn. Geoelect., Vol. 8, No. 3, 87-92 (Sept., 1956).

Assuming that a uniform parallel beam of cosmic rays at infinity is deflected in the general magnetic field of the sun, cosmic-ray intensities at each point of the earth's orbit are calculated. The problem is treated only for the equatorial plane. As the

intensities change with season, the solar diurnal variation averaged over all seasons never tends to zero, due to the heliomagnetic deflection of cosmic rays.

523.165

997. ON THE ORIGIN OF COSMIC RAYS DURING THE EARLY PART OF THE EVOLUTION OF OUR GALAXY.
L.Biermann and L.Davis.
Z. Naturforsch., Vol. 13a, No. 11, 909-15 (Nov., 1958).

The hypothesis is considered that the volume in which the cosmic rays are stored is comparable to that of the halo of the Galaxy and hence (if the total amount of gas in the halo is at most comparable with that in the disk) the average cosmic-ray life-time is comparable with the age of the Galaxy. Reasons are given which indicate that the amount of interstellar gas, the number of early type stars, and the rate of production of cosmic rays were much greater in the early part of the evolution of the Galaxy than they are now. It is shown that under these conditions the observed data on the cosmic-ray isotropy, including that of the very high energy component, and the data on the abundance of the Li, Be, B nuclei may be understood, and that in addition the conditions for the statistical (Fermi type) mechanisms of acceleration to be operative were much more favourable in the early stages than they are now.

523.5

998. ON TWO PARAMETERS USED IN THE PHYSICAL THEORY OF METEORS. L.G.Jacchia.
Smithsonian Contrib. Astrophys., Vol. 2, No. 9, 181-7 (1958).

The two parameters considered are the "fragmentation index" $\chi$, which measures the progressive departure of the observed deceleration of a fragmenting meteor from that computed from the drag equation for a single body, and a coefficient $\sigma$, which occurs in the velocity–mass equation for a fragmenting meteor. Observational results show that both $\chi$ and $\sigma$ vary similarly with the brightness of the meteors; there is also a variation with velocity.
G.M.Brown

523.59

999. ON POLARIZATION OF ZODIACAL LIGHT. V.G.Fesenkov.
Astron. Zh., Vol. 35, No. 4, 513-19 (1958). In Russian.

It is shown that the hypothesis, which asserts that polarization of zodiacal light is due to free electrons, appears to be untenable. The polarization is well accounted for on the assumption that it is due solely to scattering by dust particles. S.Chomet

523.746 : 550.385

1000. SUNSPOTS AND GEOMAGNETISM. B.Bell and H.Glazer.
Smithsonian Contrib. Astrophys., Vol. 2, No. 8, 161-79 (1958).

An investigation into the relation between geomagnetic activity and a variety of properties of sunspots, including their magnetic class, area, flare productivity, location, and radio noise emission, in an attempt to predict whether the central meridian passage (CMP) of an active centre will emit solar corpuscles (producing a geomagnetic storm) or inhibit the emission of corpuscles (producing a geomagnetically quiet condition). It is confirmed that the best criterion for identifying a storm-producing sunspot group is the emission of radio noise on metre wavelengths, while the most significant optical property is the magnetic class. Unipolar and bipolar spots give no marked geomagnetic effect, but the CMP of multipolar groups gives notable enhancements of geomagnetic activity. Sunspot area is a relatively unimportant factor; flare productivity is of moderate significance. The equinoctial maxima of magnetic activity are shown to occur at all phases of the sunspot cycle, and they are found to be unrelated to the location of sunspots on the "favourable" or "unfavourable" solar hemispheres. G.M.Brown

523.746 : 523.164.32

1001. RADIO-EMISSIVE, AND NON-RADIO-EMISSIVE SOLAR [SPOT] CENTRES. I. OPTICAL AND GEOMAGNETIC PROPERTIES. P.Simon.
Ann. Astrophys., Vol. 19, No. 3, 122-41 (1956). In French.

A statistical study has been made of the centres of radio emission (at metre wavelengths) in the inner corona associated with active sunspots of type Q, as compared with the activity of type R sunspots. The former appear not to be linked by any optical characteristic with solar flare activity. However the two groups show marked differences in their geomagnetic effects. Central meridian passage of type Q spots is associated with a significant diminution of geomagnetic activity; whilst type R spots are linked with a high probability of the onset of intense magnetic storms with sudden commencements. D.R.Barber

523.75

1002. SHORT $\gamma$-RAY BURST FROM A SOLAR FLARE.
L.Peterson and J.R.Winckler.
Phys. Rev. Letters, Vol. 1, No. 6, 205-6 (Sept. 15, 1958).

A brief burst of radiation associated with a solar flare of importance 2 at 13 05 U.T. on 20 March 1958, was detected on a balloon flight over Cuba, using a spherical integrating chamber and single Geiger counter. The observations indicated the emission of bremsstrahlung $\gamma$-rays, radiated from solar 1 MeV electrons stopped in the H-photosphere, and subsequently filtered by the terrestrial atmosphere. D.R.Barber

523.752

1003. TEMPERATURE AND TURBULENCE IN QUIESCENT PROMINENCES DETERMINED FROM LINE-WIDTHS.
P. ten Bruggencate and G.Elste.
Nature (London), Vol. 182, 1154 (Oct. 25, 1958).

Results for 10 prominences whose spectra were photographed with the Gottingen tower telescope and grating spectrograph between May 1, and June 13, 1957, are tabulated. Mean values of kinetic temperature, and turbulent velocity, calculated by a least squares method (with double weight for the Balmer H-lines), range respectively from 4500 to 8800°K, and from 3.6 to 9.2 km/sec. There is a slight, though significant, negative correlation ($r = 0.52$, $n = 39$) between kinetic temperature and turbulent velocity. D.R.Barber

523.77 : 535.417

1004. INTERFEROMETRIC MEASUREMENTS OF WAVE-LENGTHS. IV. THE ACCURACY OF MEASURED WAVE-LENGTHS.
M.G.Adam and S.Nichols.
Monthly Not. Roy. Astron. Soc., Vol. 118, No. 2, 97-105 (1958).

For Pts II-III, see Abstr. 43-4 (1957). Solar absorption lines are very different in character from the corresponding laboratory lines, and the wavelength accuracy obtainable for them is considerably less. It is moreover possible that some part of the red shift and change in red shift with line strength originates in the micrometer measurement of the broad absorption and narrow emission lines. An investigation is made of the accuracy and consistency obtainable in measuring arc and solar wavelengths by the method of circular channels. It appears from this investigation that red shifts can be obtained which are significant to better than 0.001 A.

523.77 : 535.417

1005. INTERFEROMETRIC MEASUREMENTS OF WAVE-LENGTHS. V. THE RADIAL CURRENT INTERPRETATION OF SOLAR RED SHIFTS. M.G.Adam.
Monthly Not. Roy. Astron. Soc., Vol. 118, No. 2, 106-16 (1958).

The relativity-radial current theory of solar red shifts was thought earlier to imply currents with impossibly high velocities, but with a new model atmosphere, based on 0".4 granules of high brightness contrast, Schröter (1957) finds that the shifts can be explained with streaming velocities of only 2-3 km/sec. There is quite a good agreement between Schröter theoreitcal predictions and centre to limb observations of the shift. Wavelength measures obtained by the present author at the solar centre and in the vacuum arc can also be used to test Schröter's theory. They enable us to determine the resultant streaming velocity as a function of line stregth; but these velocities do not agree with Schröter's predictions. The wavelength dependence of the shifts is examined using the Allegheny Observatory–Bureau of Standards measures; this test also fails to support the radial current interpretation.

523.872

1006. APPROXIMATE FORMULAE FOR EVALUATING THE INTENSITY OF WEAK SPECTRAL LINES. D.Barbier.
Ann. Astrophys., Vol. 19, No. 5, 223-8 (1956). In French.

The new formulae deduced give the intensities of lines arising in the atmospheres of sun and stars; they are exact for the Milne–Eddington and Schuster–Schwarzschild models. They can be used to determine atomic abundances relative to that of hydrogen.
G.F.Lothian

523.877

1007. INFLUENCE OF A SLOW ROTATION ON THE RELATIVE EQUILIBRIUM OF A GASEOUS STELLAR MASS. T.Zeuli.
Atti Accad. Sci. Torino I, Vol. 90, No. 2, 577-85 (1955-56).

523.877

1008. ON THE CALCULATION OF MODELS OF AN ATMOSPHERE IN RADIATIVE EQUILIBRIUM (NON-GREY CASE).
M.Krook and J.C.Pecker.
C.R. Acad. Sci. (Paris), Vol. 247, No. 16, 1177-9 (Oct. 20, 1958).
In French.

A modification of Strömgren's iterative procedure is proposed in order to introduce more rapid convergence. R.A.Newing

525.24

1009. DISTORTION OF THE MAGNETIC FIELD IN THE OUTER ATMOSPHERE DUE TO THE ROTATION OF THE EARTH.
K.Maeda.
Ann. Géophys., Vol. 14, No. 2, 154-66 (1958).

Deals with the possibility of a shearing distortion of the magnetic equator in the outer atmosphere. The appropriate magnetohydrodynamic wave equation is deduced and some approximations to it are discussed. Assuming a cavity surrounding the earth, the fields are obtained that must be generated by the non-axisymmetric component of the earth's dipole moment rotating with the earth. It is shown that the dip equator will shift westwards in the outer atmosphere.

525.3

1010. POLYHEDRAL SATELLITE FOR MORE ACCURATE MEASUREMENT OF ORBIT DATA OF EARTH SATELLITES.
D.R.Herriott.
J. Opt. Soc. Amer., Vol. 48, No. 9, 667-8 (Sept., 1958).

A multi-faced specular reflecting surface for an earth-satellite would possess the combined advantages of (a) greatly increasing the intensity of the received light flux; (b) improving the accuracy of measurement of the orbital parameters by means of the resulting brief pulses of reflected sunlight; (c) enabling automatic instrumentation to be used in detecting and following the satellite. Relevant data are given for a 270-sided body. D.R.Barber

525.3 : 523.75

1011. EFFECT OF SOLAR FLARES ON EARTH SATELLITE 1957 $\beta$. T.Nonweiler.
Nature (London), Vol. 182, 468-9 (Aug. 16, 1958).

An apparent correlation appears if the rate of decrease of period of the earth satellite 1957 $\beta$, and concurrent variation in the total intensity of major solar flares, are compared. The sense of the correlation implies that world-wide decreases of ionospheric air temperature, or of air density, or both, result from the flare activity. D.R.Barber

525.3

1012. CHANGE OF INCLINATION OF A SATELLITE ORBIT.
C.H.Bosanquet.
Nature (London), Vol. 182, 1533 (Nov. 29, 1958).

It is shown that the decrease of inclination ($\sim 0.15^{0}$) of the orbit of earth satellite 1957 $\beta$ during its lifetime was due to the cross-wind set up by the earth's rotation. D.R.Barber

525.3

1013. DOPPLER MEASUREMENTS ON SOVIET SATELLITES.
A.H.Allan and J.E.Drummond.
New Zealand J. Sci., Vol. 1, No. 2, 143-53 (June, 1958).

Measurements of the Doppler change in frequency during the passage of the transmitters on the first two Soviet satellites were successfuly used to predict the times and elevations at which the satellites could be seen and photographed.

525.3

1014. FURTHER RADIO OBSERVATIONS ON ARTIFICIAL SATELLITES. P.F.Checcacci and C.Carreri.
Ricerca sci., Vol. 28, No. 9, 1817-31 (Sept., 1958). In Italian.

Data are presented for Sputniks I and II, Explorer I and II, and Test Vehicle 4.

525.3 : 523.164.8 : 621.396.969.35 : 621.396.946

1015. RADIO OBSERVATIONS ON THE FIRST RUSSIAN ARTIFICIAL EARTH SATELLITE.
Trans S. African Inst. Elect. Engrs, Vol. 48, Pt 12, 363-9 (Dec., 1957).

Doppler measurements made in Johannesburg, South Africa, on the first Russian earth satellite are described. The orbit of the satellite is derived from these measurements using an approximate method of calculation in which ionospheric effects are neglected and an eccentric circular orbit is assumed.

525.3 : 531.355

ELLIPTIC ORBITS IN A FRICTIONAL ATMOSPHERE. LIFETIME OF ARTIFICIAL SATELLITES. See Abstr. 73

# PHYSICS

## GENERAL

530.1

1016. APPROXIMATE NATURE OF PHYSICAL SYMMETRIES.
P.Morrison.
Amer. J. Phys., Vol. 26, No. 6, 358-68 (Sept., 1958).

It is now clear that a priori judgment is inadequate to establish the presence of exact symmetries in the physical laws, and the exact conservation laws which follow from them. The latest example has been the Yang–Lee demonstration of the failure of mirror invariance in the weak interactions. It is possible to conjecture that even the kinematical symmetries under continuous transformations which give energy–momentum conservation may be inexact; their failure may be expressed, for example, in the spontaneous creation of nucleons postulated by Bondi and Gold. Still further, one may at least raise the question of the exactness of general relativity, or rather of the principle of equivalence between acceleration and a uniform gravitational field. If this equivalence is regarded as an approximate consequence of the predominance of matter over antimatter in our environment, it is possible to frame a consistent scheme which predicts large-scale symmetry between matter and antimatter, but at the expense of introducing gravitational repulsion. Conceptual experiments are constructed to show the consistency of this picture at least in the Newtonian limit; certain specified conditions on the gravitational behaviour of various types of inertial mass must be satisfied.

## GRAVITATION. RELATIVITY

530.12

1017. A BRIEF SURVEY OF SOME PROBLEMS IN GRAVITATION.
V.V.Narlikar.
Bull. Calcutta Math. Soc., Vol. 49, No. 1, 1-7 (March, 1957).

530.12

1018. BOUNDARY CONDITIONS AT INFINITY FOR PHYSICAL THEORIES. A.Trautman.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 6, 403-6 (1958).

Boundary conditions for scalar and Maxwell fields are formulated in a form which exhibits their physical meaning and which is suitable for generalization to the gravitational case. J.C.Taylor

530

1019. ON A QUANTIZATION PROCEDURE FOR THE GRAVITATIONAL FIELD. A.Lichnerowicz.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 433-6 (July 28, 1958).
In French.

The gravitational field is described in Minkowski space–time by a tensor $H_{\alpha\beta,\lambda\mu}$ having the same algebraic properties as a Riemannian curvature tensor. The quantization procedure introduced is analogous to that for an electromagnetic field.

R.A.Newing

530.12

1020. ON GRAVITATIONAL RADIATION. L.Bel.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1094-6 (Oct. 13, 1958).
In French.

A tensor, a scalar and a vector are defined and shown to have properties analogous to the Maxwell tensor, the energy density and the Poynting vector familiar in the study of electromagnetic radiation. The scalar and the vector are associated with a time-like direction and it is proposed that, for such directions at any point, a state of gravitational radiation may be defined where the "Poynting" vector is different from zero. T.R.Carson

530.12

1021. SCALAR FIELD THEORY AS A THEORY OF GRAVITATION. P.Kustaanheimo.
Comment. phys.-math. (Helsinki), Vol. 21, No. 3, 9 pp. (1958).

A general scalar field theory of gravitation is formulated under different axioms. It is found that two or three of the crucial tests can take arbitrary numerical values according to whether one or three of these axioms are omitted. If all axioms are valid, then there is no deflection of light, the red shift is the same as in general relativity, and the perihelion advance remains arbitrary. G.Stephenson

530.12

1022. JEANS' FORMULA FOR GRAVITATIONAL INSTABILITY. W.B.Bonnor.
Monthly Not. Roy. Astron. Soc., Vol. 117, No. 1, 104-17 (1957).

Jeans' formula gives the condition that a gravitating mass of gas shall be stable to small fluctuations in the density. It was originally obtained for a static mass of uniform density, and the proof is questionable. In the present paper the formula is derived by studying small perturbations of the density and velocity in an expanding Newtonian world-model. It turns out that, given a suitable interpretation of the quantities involved, the formula is valid in all cosmologies except the steady-state theory. Although instability occurs in the models as suggested by Jeans' formula, the condenstion process is too slow to account for the formation of the nebulae — a result which has now been reached in several ways, and which may be regarded as well-established. In the Newtonian version of the steady-state theory small perturbations of the average density die out, and so Jeans' formula does not apply. The relevance of this to the work of Sciama, who assumes the contrary, is discussed. It seems that the claim that the steady-state theory explains the formation of the nebulae requires further substantiation.

530.12

1023. THE UNITARY FIELD THEORY IN THE MAXWELL APPROXIMATION. J.Pachner.
Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 1-2, 36-40 (1958).
In German.

The condition is examined under which the equations of a unitary theory become identical with those of the general theory of relativity. It is found that, owing to the absence of a certain scalar density from the Hamiltonian, the condition is not satisfied in Einstein's, unitary theory. W.A.Hepner

530.12

1024. ON A UNIFIED FIELD THEORY BASED ON THE SPECIAL THEORY OF RELATIVITY. P.Kustaanheimo.
Comment. phys.-math. (Helsinki), Vol. 21, No. 4, 10 pp. (1958).

A single potential function is introduced into special relativity which, it is claimed, accounts for both the inertia of the particles and their electromagnetic and gravitational interaction. The theory is independent of the units of charge and mass and contains no dimensional constant of gravitation. It is shown that the theory gives the classical gravitational and electromagnetic theories in the first approximation and an arbitrary perihelion advance in the second approximation. G.Stephenson

530.12

1025. GENERAL RELATIVITY AND MACH'S PRINCIPLE. W.Davidson.
Monthly Not. Roy. Astron. Soc., Vol. 117, No. 2, 212-24 (1957).

Sciama (Abstr. 3063/1953), among others, has taken the view that general relativity has failed to account satisfactorily for the inertial properties of matter. The present paper shows that general relativity is entirely consistent in principle with Sciama's ideas of inertia as an inductive effect predominantly of distant matter, and that therefore Sciama's remarks concerning general relativity are not justified. It is shown that general relativity provides a superior presentation of Sciama's idea of Mach's principle and appears to be the general tensor theory Sciama was looking for. Arguments are put forward to show that general relativity may fully incorporate Mach's principle contrary to Einstein's own belief. This paper emphasizes the fitness of the steady state theory as a cosmological solution which permits this possibility.

530.12

1026. NEW APPROACH TO GENERAL RELATIVITY. H.Yilmaz.
Phys. Rev., Vol. 111, No. 5, 1417-26 (Sept. 1, 1958).

A generally covariant scalar field theory of gravitation is presented. The principle of equivalence as well as the principle of general covariance are preserved. A functional solution of Einstein's field equations is obtained for the general time-independent case. The theory predicts correctly the results of the three crucial tests of general relativity. Implications concerning the self-energy of point particles is presented. A new theory of cosmology is given and its application to the time-scale problem and to the derivation of the Mach principle are discussed. A new principle called the principle of observation is introduced.

530.12

1027. CONSERVATION LAWS IN GENERAL RELATIVITY AS THE GENERATORS OF COORDINATE TRANSFORMATIONS. P.G.Bergmann.
Phys. Rev., Vol. 112, No. 1, 287-9 (Oct. 1, 1958).

The components of the so-called canonical energy-stress pseudo tensor in general relativity may be thought of as the generators of infinitesimal coordinate transformations corresponding to a rigid parallel displacement of the coordinate origin, just as in Lorentz-covariant theories. In this paper it is shown that the canonical expressions, as well as the expressions proposed by Landau and Lifshitz and the expressions for the angular momentum density, are all special cases of an infinity of conservation laws whose pseudovectors generate arbitrary curvilinear coordinate transformations. This approach enables one to construct the transform of every one of thes conservation laws under an arbitrary (finite) coordinate transformation. Finally it is shown that every one of these conservation laws may be used to obtain a surface integral relationship that describes the motion of singularities in a general-relativistic theory. It is concluded that there is an infinite number of parameters that describes a singularity of the field, a fact that had previously been in doubt.

530.12

1028. KLEIN–GORDON AND DIRAC EQUATIONS IN GENERAL RELATIVITY. J.Callaway.
Phys. Rev., Vol. 112, No. 1, 290 (Oct. 1, 1958).

It is shown, that when account is taken of the gravitational field of a point charge, the Klein–Gordon and Dirac equations for the motion of a charged particle in a Coulomb field do not possess solutions which can be expressed as series of terms proportional to positive integral powers of the gravitational constant.

530.12

1029. INTEGRATION OF SECONDARY CONSTRAINTS IN QUANTIZED GENERAL RELATIVITY. P.W.Higgs.
Phys. Rev. Letters, Vol. 1, No. 10, 373-4 (Nov. 15, 1958).

An alternative approach to that of Dirac's (Abstr. 5608-9/1958) for quantizing general relativity is given by constructing a modified Lagrangian. By imposing harmonic coordinate conditions on the state functionals, the Einstein field equations for the matrix elements of potentials are then restored. The Hamiltonian derived from the modified Lagrangian is the same as found by Dirac. G.Stephenson

530.12

1030. NEW EXPERIMENTAL TEST OF SPECIAL RELATIVITY. J.P.Cedarholm, G.F.Bland, B.L.Havens and C.H.Townes.
Phys. Rev. Letters, Vol. 1, No. 9, 342-3 (Nov. 1, 1958).

The relative frequency stability of two beam-type maser oscillators is used to test the dependence of the velocity of light on velocity of the frame of reference with greater accuracy than the Michelson–Morley type experiments. The change in beat frequency is of the order of $\frac{1}{50}$ c/s corresponding to an ether drift of $\frac{1}{1000}$ of the earth's orbital velocity. This value is considerably smaller than the result obtained by Miller from a Michelson–Morley type experiment. G.Stephenson

530.12 : 531.12

1031. ON POSTULATES COMMON TO CLASSICAL AND RELATIVISTIC KINEMATICS. C.Cattaneo.
R.C. Accad. Naz. Lincei, Vol. 24, No. 5, 526-32 (May, 1958).
In Italian.

A set of postulates is introduced which permit the derivation of the Lorentz transformation, if a constant arising in the derivation is

identified with $-1/c^2$; classical kinematics corresponds to the particular case in which this constant is zero. R.A.Newing

530.12 : 538.3

RELATIVISTIC ELECTROMAGNETIC EQUATIONS AS COVARIANT EQUATIONS IN 3-SPACE. See Abstr. 462

# FIELD THEORY. QUANTUM THEORY

530.145

1032. THE SIGNIFICANCE OF PLANCK'S QUANTUM THEORY FOR EXPERIMENTAL PHYSICS. G.Hertz.
Naturwissenschaften, Vol. 45, No. 17, 401-5 (1958). In German.

Lecture given on the occasion of the centenary celebrations of Max Planck's birthday. W.A.Hepner

530.145

1033. ON THE EUCLIDEAN STRUCTURE OF RELATIVISTIC FIELD THEORY. J.Schwinger.
Proc. Nat. Acad. Sci. U.S.A., Vol. 44, No. 9, 956-65 (Sept., 1958).

The truth of the following proposition is discussed: that to any field theoretic system there corresponds, in a fictitious Euclidean space, an image system defined by equations between Green's functions or even by field equations; and that there is a well defined procedure for translating results from one system to the other. Conditions for this proposition to be true are that all fermion fields should carry a charge (identified as baryonic or leptonic), and that CP invariance should hold. J.C.Taylor

530.145

1034. COPENHAGEN INTERPRETATION OF QUANTUM THEORY. N.R.Hanson.
Amer. J. Phys., Vol. 27, No. 1, 1-15 (Jan., 1959).

The theoretical and experimental context within which the "Copenhagen Interpretation" of quantum theory was generated is underemphasized by recent critics of the Bohr–Heisenberg philosophy. When an interpretation of a theory has been as successful as this one has been, there is little practical warrant for the "alternative interpretations" which have, since Bohm, been receiving prominence. Indeed, these are not even genuine alternatives; although rich in provocative prose, they provide not a scrap of algebra with which to organize the practical physicist's thinking Several objections to the Bohr interpretation are critically examined as is also a particular use of the correspondence principle which has seemed to cast doubt on the "Copenhagen" ideas.

530.145

1035. ON HEISENBERG'S PROOF OF THE UNCERTAINTY RELATIONS. F.M.Comide and G. Braga Rego.
An Acad. Brasil. Cienc., Vol. 28, No. 2, 179-81 (1956).

530.145

1036. QUANTUM MECHANICS AND GEOMETRY. II. M.Schönberg.
An. Acad. Brasil. Cienc., Vol. 30, No. 1, 1-20 (1958).

For Pt I, see Abstr. 8579 (1958). Shows that the mathematical formalisms of quantum mechanics and field theory are of a geometric nature. P.M.Davidson

530.145

1037. THE INTEGRATION IN FUNCTIONAL SPACES AND ITS APPLICATIONS IN QUANTUM THEORY.
I.M.Gelfand and A.M.Jaglom.
Fortschr. Phys., Vol. 5, No. 10-11, 517-56 (1957). In German.

Translation from Uspekhi Matematichesikh Nauk, Vol. 11, 77 (1956). This is a survey of the methods and applications of functional integration since its first use by Feynman (Abstr. 3107/1948). W.A.Hepner

530.145 : 539.165

1038. EFFECTS OF PTC-NONINVARIANCE IN THE RADIATIVE CAPTURE OF ORBITAL ELECTRONS. S.Nagata.
Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 4, 151-5 (Jan., 1958).

It is shown that the invariance of beta-decay interaction under the space inversion, time reversal and charge conjugation can be tested by observing the angular distribution of continuous gamma-rays or the gamma–neutrino angular correlation accompanying nuclear capture of atomic K-electrons.

530.145

1039. ERGODIC THEOREM IN QUANTUM MECHANICS. P.Bocchieri and A.Loinger.
Phys. Rev., Vol. 111, No. 3, 668-70 (Aug. 1, 1958).

Landsberg and Farquhar have shown that the von Neumann–Fierz approach to the quantum ergodic problem does not give any criterion of ergodicity. In this paper it is shown that von Neumann's procedure of averaging over the macro-observers is sufficient by itself to "justify" at every time the use of the quantum microcanonical ensemble. It is then proved that the time behaviour of the system is completely irrelevant to the demonstration of the von Neumann and von Neumann–Firez ergodic theorems. It is concluded that the quantum ergodic problem must be attacked on entirely new lines.

530.145

1040. REMARK ON THE GENERALIZATION OF FIELD THEORIES AND FIELD QUANTITIES. W.R.Davis.
Z. Naturforsch., Vol. 12a, No. 8, 658-9 (1957). In German.

Some consequences of dealing with fields more general than those investigated by Bergmann and others are considered. W.A.Hepner

530.145

1041. FIELD THEORY. I. CLASSICAL THEORY. J.Rzewuski.
Warsaw: Panstwowe Wydawnickwo Naukowe (1958) 297 pp. [Physical Monographs].

This is a book on the classical theory of fields, written largely as an introduction to the study of quantum theory. Spinor and tensor fields are introduced in a very brief account of the representations of the Lorentz group, with, however, some detail on the different representations of space and time inversion. There are numerous examples of interacting fields and methods of solution, including non-local interactions. There is a detailed chapter on the $\Delta$-functions and their classical interpretation. J.C.Taylor

530.145

1042. LAWS OF CONSERVATION: PARITY AND TIME REVERSAL. T.-Y.Wu.
Amer. J. Phys., Vol. 26, No. 8, 568-76 (Nov., 1958).

The concept of conservation of parity is explained, and the reason for the usual transformation laws for electric charge, electric field, magnetic pole, and magnetic field as scalar, vector, pseudo-scalar and pseudo-vector, respectively, is traced to the requirement that the laws of electromagnetism be invariant under inversion. The work of Lee, Yang, Wu et al, is then briefly summarized. The usual canonical transformations in classical dynamics are extended to include time reversal by extending the usual conditions for canonical transformations. Thus upon time reversal the Poisson brackets undergo a change of sign. If the behaviour of the quantum Poisson brackets upon time reversal is analogously defined, it seems to provide an alternative view to the invariance of the Schrödinger or Heisenberg equations in quantum mechanics under the Wigner time reversal.

530.145

1043. ON PERTURBATION CALCULATIONS CARRIED OUT BY VAN VLECK'S METHOD. S.Maes and G.Amat.
Cahiers de Phys., Vol. 11, 277-84 (July, 1957). In French.

The use of a unitary transformation to simplify second-order perturbation calculations is discussed. R.J.N.Phillips

530.145

1044. REDUCTION OF PRIMARY CONSTRAINTS IN GENERALLY COVARIANT FIELD THEORIES. J.L.Anderson.
Phys. Rev., Vol. 111, No. 3, 965-6 (Aug. 1, 1958).

Generally covariant field theories have associated with them, in the canonical formalism, a series of primary and secondary constraints. For a large class of these theories it is proven that there exists a transformation which will reduce the primary constraints to the form of a set of momenta equal to zero. The transformation which accomplishes this reduction is exhibited explicitly for the case of general relativity.

530.145

1045. THEORY OF THE INTERNAL SPACE. W.E.Thirring.
Phys. Rev., Vol. 111, No. 3, 986-94 (Aug. 1, 1958).

It is postulated that fermions with identical space–time properties have to obey the exclusion principle unless they differ dynamically in their interaction with other particles. This postulate is formulated within the framework of a theory of the internal degrees of freedom. When all possible Yukawa-type couplings are examined, this postulate together with some other specification

singles out the $\phi \cdot \tau$ interaction between pion and nucleon. When applied to electric interactions it requires the displacement of the nucleon centre of charge.

530.145

1046. VERTEX FUNCTION IN QUANTIZED FIELD THEORIES. R.Oehme.
Phys. Rev., Vol. 111, No. 5, 1430-2 (Sept. 1, 1958).

An integral representation is given for the vertex function $F(k^2, p^2, (k-p)^2)$. This representation is obtained on the basis of local commutativity and the spectral conditions. It exhibits the set of points $k^2, p^2$, for which F is analytic in $(k-p)^2$ except for the physical cut. The limitations found in the representation are discussed on the basis of examples obtained from perturbation theory. These examples give some insight into the question of further analytic continuation in $k^2$ and $p^2$.

530.145

1047. INTEGRAL REPRESENTATION OF A DOUBLE COMMUTATOR. F.J.Dyson.
Phys. Rev., Vol. 111, No. 6, 1717-18 (Sept. 15, 1958).

An integral representation is found for the vacuum expectation value of a double commutator. The problem of incorporating the Jacobi identity into such a representation remains unsolved.

530.145

1048. ON THE REGULAR REPRESENTATION OF THE LORENTZ GROUP. P.Budini.
Rev. Univ. Tucuman A, Vol. 11, No. 1-2, 84-93 (1957).

The regular representation of the homogeneous Lorentz group is defined in a six-dimensional subspace of an eight-dimensional space. The infinitesimal operators of the group and the invariants are defined and explicitly given in the space of the representation. The eigenvalue spectra of the invariants are discussed, and in particular it is shown that for the critical interval the eigenfunctions of the invariants are not square integrable in the space of the representation.

530.145

1049. CLASSICAL SOLUTIONS OF HEISENBERG'S NONLINEAR FIELD EQUATION. K.Just.
Z. Naturforsch., Vol. 13a, No. 4, 345-6 (April, 1958). In German.

A result about the oscillating behaviour of the solutions (see Abstr. 8030/1954) is obtained by considering certain approximations to special solutions of the unquantized equation.

W.A.Hepner

530.145

1050. NONLINEAR THEORY OF VECTOR FIELDS. V.Yu.Urbakh.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 208-15 (1958). In Russian.

In analogy with Einstein's theory of gravitation, the existence of a vector physical field is interpreted as a curvature of a certain "non-Pythagorian" space with the metric $ds = \gamma_i dx^i$. This yields nonlinear field equations which in the linear approximation (for weak fields) go over to the usual equations. Despite the singularity of the potential the total energy of the field of a point charge is finite.

530.145

1051. ON THE FORMATION OF QUANTUM-MECHANICAL OPERATORS. J.R.Shewell.
Amer. J. Phys., Vol. 27, No. 1, 16-21 (Jan., 1959).

A number of rules for forming operators corresponding to classical quantities are investigated. Spin and relativistic effects are excluded from consideration. The two rules which are in agreement with the customary interpretation of quantum mechanics are ambiguous in that they do not yield unique operators. The other rules considered yield unique operators but are in disagreement with the customary interpretation of quantum mechanics. It is shown that any symmetrization rule is in this category. All the rules investigated are linear, but no attempt is made to formulate a nonlinear rule. It is indicated that additional experimental evidence is necessary to clarify the question of quantum-mechanical operators.

530.145

1052. MOBILE ELECTRON MODEL IN A MAGNETIC FIELD. J.A.Weil.
J. chem. Phys., Vol. 29, No. 4, 792-6 (Oct., 1958).

The motion of an electron in a circular loop containing equally spaced Dirac delta-function potential spikes is considered. This problem is solved exactly for the case when a static magnetic field is present, and is of physical interest for the $\pi$-electron motions in benzene.

530.145

1053. ON THE POSSIBLE LIMIT OF APPLICABILITY OF QUANTUM ELECTRODYNAMICS. D.I.Blokhintsev.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 254-7 (1958). In Russian.

Processes competing with electromagnetic processes at high energies are considered. It is shown that possible processes of this type are those connected with four-fermion interactions.

530.145 : 539.12

1054. A PARITY-CONSERVING INTERACTION APPLIED TO K–PION DECAY. W.H.Nichols.
Ann. Phys. (New York), Vol. 5, No. 2, 141-55 (Oct., 1958).

A specific interaction Lagrangian for an isotopic doublet boson is proposed which, to the first approximation in a perturbation expansion, can account for the lifetimes and branching ratios in $K-\pi$ decays. Since parity is rigorously conserved in all $K-\pi$ interactions, the K-meson is described as a parity doublet. The total Lagrangian is invariant under charge conjugation and time reflection. The strong interaction, of the form $g_S \varphi_K^\dagger \sigma^\dagger \chi_K \chi_\pi$, is a scalar in isotopic space and is invariant under parity conjugation (in order to have scalar and pseudoscalar K masses equal). The weak interaction, of the form $g_W(\sigma + \alpha\ \sigma_0 \chi_K \chi_\pi)$, allows a change in total isotopic spin of $\frac{1}{2}$ or $\frac{3}{2}$. The final-state pions are considered to be in plane-wave states. The following dimensionless constants are obtained: $g_S = 1.6$; $g_W = 5 \times 10^{-8}$; $\alpha = -0.16$. No account is taken of any of the K-decay modes involving neutrinos, nor of the production or scattering properties of the K-particles. The eight theoretically distinct K-mesons are reduced in number to the four actually distinguishable in K-decays.

530.145

1055. A NOTE ON FERMI INTERACTIONS. T.Takabayasi.
C.R. Acad. Sci. (Paris), Vol. 247, No. 19, 1571-4 (Nov. 10, 1958). In French.

A discussion of the invariance of the interactions under permutations of the participating fields. J.C.Taylor

530.145

1056. ON A VARIATIONAL PRINCIPLE IN THE STATISTICAL MANY BODY PROBLEM. I.A.Kvasnikov and V.V.Tolmachev.
Dokl. Akad. Nauk SSSR, Vol. 120, No.2, 273-6 (1958). In Russian.

A statistical variational principle similar to that of Bogolyubov (Abstr. 3719/1958) is presented in a form suitable for studying a system interacting Fermi particles. Expressions are obtained for the thermodynamic potential, the results reducing to those of Bogolyubov at zero temperature. The method is applied in detail to a system, the Hamiltonian of which includes the interaction between pairs of particles with opposite momenta. The critical temperature at which superfluidity appears in nuclear matter is considered and a detailed discussion is given of the stability of the "normal" states of the system. M.J.Kearsley

530.145

1057. A MODEL OF THE UNIVERSAL FERMI INTERACTION. J.Leite Lopes.
Nuclear Phys., Vol. 8, No. 2, 234-6 (Sept. [2], 1958).

It follows from the Feynman–Gell-Mann theory that the Fermi interaction can be regarded as due to an exchange of charged vector mesons between fermions. An alternative model is possible: the weak couplings among fermions may be due to an exchange of charged and neutral vector mesons. An extra condition of conservation of the current which creates the neutral field is imposed to forbid unobserved reactions. The model differs from the Feynman–Gell-Mann picture in that it leads to an intrinsic electron–neutron interaction, the effective potential being of the order of 4 eV. If the coupling of this hypothetical vector meson with fermions has the same strength as the electric charge, the particle will have about 60 proton masses and will decay very fast into pairs of hyperons.

530.145

1058. A UNIFIED THEORY OF THE FERMI INTERACTION. T.Toyoda.
Nuclear Phys., Vol. 8, No. 6, 661-74 (Nov. [2], 1958).

A method developed by Infeld and van der Waerden for generalizing the free Dirac field equation into the scheme of general relativity is used to unify the interaction types by adding some new hypotheses but still remaining in the usual Minkowski space. An explanation for a modified Pauli–Gürsey transformation is given in relation with the coupling types. Neither conventional isospinspace nor strangeness quantum number are used, but only the usual three dimensional spin space is necessary. The results seem to be similar to those of the Feynman–Gell-Mann theory, except for a few points. A comparison with their theory is made.

530.145 : 539.12

1059. EXPERIMENTAL TEST OF TIME-REVERSAL INVARIANCE IN STRONG INTERACTIONS. A.Abashian and E.M.Hafner.
Phys. Rev. Letters, Vol. 1, No. 7, 255-6 (Oct. 1, 1958).

An experiment was performed to compare the polarization and the asymmetry produced in p–p scattering, using carbon as an analyser or polarizer respectively. The approximate equality of the two numbers found shows that Wigner time-reversal invariance cannot be violated by more than a few percent. J.C.Taylor

530.145 : 539.14

NUCLEON–NUCLEON INTERACTION. See Abstr. 563

530.145

1060. ON THE THEORY OF THE DIRAC PARTICLE WITH ORIENTATED SPIN. A.Sokolow and B.Kerimow.
Ann. Phys. (Leipzig), Folge 7, Vol. 2, No. 1-2, 46-53 (1958). In German.

See Abstr. 1823/1958.

530.145

1061. TENSORS OF THE PAULI GROUP. J.Géhéniau.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 44, No. 5, 418-22 (1958). In French.

The tensor quadratic functions of the components of a spinor and its Hermitian conjugate are classified by the Pauli group in isoscalars and isovectors. Some identities are given. Relations between the present formalism and Gürsey's are mentioned.

530.145

1062. ON THE INTERNAL DEGREES OF FREEDOM OF PARTICLES IN QUANTUM FIELD THEORY. I.Białynicki-Birula.
Bull. Acad. Polan. Sci. Cl. 3, Vol. 5, No. 9, 905-9 (1957).

A method for representing the polarization of a particle of arbitrary spin is described. J.C.Taylor

530.145

1063. THE LAGRANGIAN WITH HIGHER ORDER DERIVATIVES AND THE MECHANICAL SPIN OF A PARTICLE. L.Infeld.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 10, 979-83 (1957).

An extension of previous work in special relativistic mechanics (Abstr. 8974/1957) to Lagrangians which depend on the coordinate and its first two derivatives with respect to proper time. A Lagrangian depending only on this second derivative, representing a mechanical picture of a spinning particle, is discussed. R.J.N.Phillips

530.145

1064. THE LAGRANGIAN AS A FUNCTION ONLY OF COORDINATES AND THE MECHANICAL SPIN OF A PARTICLE. L.Infeld.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 10, 985-9 (1957).

See also preceding abstract. An alternative and closely analogous picture of a spinning particle is obtained, from a Lagrangian containing no derivatives, by slightly generalizing the principles of mechanics. R.J.N.Phillips

530.145

1065. ON THE SELF-STRESS OF COMPOSITE PARTICLES. J.Strathdee and Y.Takahashi.
Nuclear Phys., Vol. 8, No. 1, 113-23 (Sept. [1], 1958).

It is proved that the Pais–Epstein formula which shows the close relation between self-stress and self-energy holds true even for bound states. This formula is used to show that the self-stress of the composite particle vanishes in the rest frame, i.e. that the binding energy transforms like a mass. This makes it possible for the composite particle models proposed by many authors in connection with strange particles to join company with the relativistic particles.

530.145

1066. ON GENERALIZED FOLDY–WOUTHUYSEN TRANSFORMATIONS. D.L.Pursey.
Nuclear Phys., Vol. 8, No. 5, 595-601 (Nov. [1], 1958).

The Foldy–Wouthuysen transformation (see Abstr. 5526/1950) is generalized in one direction to yield a non-relativistic approximation procedure for an arbitrary number of interacting Dirac particles, and in another direction to give an extreme relativistic approximation for a single particle in an external field. The application of the formalism to high-energy scattering is briefly sketched. Ambiguities in the procedure are discussed, and are shown to be equivalent, within the validity of the approximation, to unitary transformations of the approximate theory.

530.145

1067. ON THE ONE-DIMENSIONAL SPINOR MODEL OF THIRRING. T.Pradhan.
Nuclear Phys., Vol. 9, No. 1, 124-39 (Nov. [3], 1958).

Thirring's method of solution (see Abstr. 2758/1958), in so far as it pertains to the construction of the S-matrix, is discussed and an expression for the S-operator in terms of certain constants of motion of the model is obtained. It is also shown that some modifications in the method employed by Glaser (An explicit solution of the Thirring model, CERN, Geneva) to obtain an explicit and complete solution of the model are necessary in view of the fact that the number-density operators in the model are not c-numbers. Certain other features of the model, such as the vanishing of the rest-mass of physical particles and the possible existence of "ghost" difficulty, are also discussed.

530.145

1068. TWO-COMPONENT FERMION THEORY. L.M.Brown.
Phys. Rev., Vol. 111, No. 3, 957-64 (Aug. 1, 1958).

The relativistic generalization of Pauli's equation for the electron has motivated Feynman and Gell-mann to propose a specific form of universal Fermi interaction. Particles satisfying this equation are studied from the viewpoint of their electromagnetic interaction. It is found that an anomalous magnetic moment similar to the Pauli moment violates the Hermiticity of the theory, and that only vector and axial vector interactions lead to simple two-component equations, even with parity conservation. Rules for calculation in quantum electrodynamics are developed which have definite advantages over the usual Dirac formulation.

530.145

1069. MAJORANA FORMULA. A.Meckler.
Phys. Rev., Vol. 111, No. 6, 1447-9 (Sept. 15, 1958).

The Majorana formula for the transition probability of a general spin is rederived and brought into a more compact form. The method is based on the use of the projection operators which characterize the spin vector as definitely quantized along a specified unit vector. If the Hamiltonian contains only terms linear in the spin, it is possible to define a moving instantaneous axis along which the moving spin vector maintains its quantization. The Majorana problem is reduced to the calculation of the joint probability of quantization along two different axes. The usual expression of the Majorana formula contains a factor which is the transition probability of a spin-$\frac{1}{2}$ vector. It is shown how this factor is related to the angle through which the general spin is turned.

530.145

1070. RELATIVISTIC FIELD THEORY OF UNSTABLE PARTICLES. P.T.Matthews and A.Salam.
Phys. Rev., Vol. 112, No. 1, 283-7 (Oct. 1, 1958).

An attempt is made to clarify the fundamental physical basis of the intrinsic characteristics of unstable elementary particles and to replace the conventional, purely phenomenological, description in terms of decaying states and complex energy levels, by definitions which are consistent with general requirements of relativistic quantum mechanics like Hermiticity, unitarity, and causality.

530.145

1071. A NEW APPROACH TO THE QUANTUM THEORY OF THE ELECTRON. H.C.Corben.
Rev. Univ. Tucuman, A, Vol. 11, No. 1-2, 66-83 (1957).

The quantum theory of fields is formulated in such a way that the expectation values of the four coordinates in the classical field theory become independent variables of a differential equation, the state vector of the system being a function of these variables. Clearly, these four expectation values cannot be sufficient to describe a quantized field, and it is shown that for complete specification one must also introduce the second, third, etc., moments of the charge distribution about the centre of charge. These represent internal coordinates of the field. As an application it is shown, e.g. how one can construct a state of the quantized Dirac field which in the classical limit satisfies Maxwell's equations, and another state which in this limit satisfies the Dirac equation for the neutrino. P.Roman

530.145

1072. ON THE THEORY OF PARTICLES WITH HIGHER SPINS. L.A.Shelepin.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1574-86 (1958). In Russian.

An algebraic method for investigation of the relativistically invariant equations for particles with higher spins is proposed. The direct product of the generalized Dirac algebras underlies the analysis. The method permits one to determine in an explicit form

the matrices of an infinitesimally small rotation, spin, metric and reflection and also to restrict the number of representations under consideration. The equations can be investigated directly either in the tensor or spin-tensor form. Commutation relations in a parametric form are obtained automatically.

530.145

1073. PERIODIC SOLUTIONS OF THE NON-LINEAR GENERALIZED DIRAC EQUATION. D.F.Kurdgelaidze.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1587-92 (1958). In Russian.

The non-linear Dirac equation is considered and a method for its solution is proposed. Periodic solutions in the general form are obtained. A relation between the non-linear Dirac equation and the Klein—Gordon equation is established

530.145 : 539.12

1074. POLARIZATION OF SPIN ONE PARTICLES BY NUCLEAR SCATTERING. S.W.Mac-Dowell and J.Tiomno.
An. Acad. Brasil. Cienc., Vol. 28, No. 2, 157-63 (1956).

This gives the mathematical machinery necessary to describe, in terms of phase shifts and the density matrix, double scattering of deuterons by spin 0 nuclei. A feature of previous experimental results is discussed. J.C.Taylor

530.145

1075. DISPERSION RELATIONS AND SCHWARTZ'S DISTRIBUTIONS. J.G.Taylor.
Ann. Phys. (New York), Vol. 5, No. 4, 391-8 (Dec., 1958).

The equivalence between strict causality and dispersion relations for a system with an output which is a linear time-independent function of the input is shown to hold under the very general condition that the time-delay distribution A(t) is a tempered distribution in the sense of Schwartz. This result is necessary for a rigorous discussion of the dispersion relations in quantum field theory and in particular is used to prove the theorem of "boundedness in the edge of the wedge" which has been used in that proof, and also in discussions of causality in quantum field theory.

530.145

1076. ON THE DETERMINATION OF THE GROUND STATE OF A FERMION SYSTEM IN THE DEGENERATE CASE.
C.Bloch and J.Horowitz.
Nuclear Phys., Vol. 8, No. 1, 91-105 (Sept. [1], 1958). In French.

The linked diagram expansion of the ground-state energy and wave-function of a system of fermions are extended to the case where the ground state of the unperturbed system is degenerate, as, for instance, in a nucleus with an incomplete shell. The state where all the complete shells are filled is taken as vacuum state. It is then shown, to all orders in the perturbation expansion, that the energy of the first levels is given by the sum of two terms. The first term, is the energy of the core alone and is given by a linked diagram expansion of the usual form. The second term is the energy of the particles outside the core. It is obtained by solving an eigenvalue problem in the space of the degenerate unperturbed wavefunctions. The corresponding eigenfunctions are given by linked diagram expansions very similar to the usual ones. A few generalizations of the method, and its relation to the Brillouin—Wigner perturbation method are discussed.

530.145

1077. LEVEL DENSITY OF DEGENERATE FERMI SYSTEMS. T.Ericson.
Nuclear Phys., Vol. 8, No. 3, 265-82 (Oct. [1], 1958).

Model-independent expressions for the level density of systems of non-interacting fermions are given in a form that is suitable for treating degenerate systems. No formal distinction is made between discrete and continuous distribution of the single fermion states. The explicit solution as well as approximate formulae in various limiting cases are given for the case when the single fermion distribution can be analysed in a power series or a Fourier series. As an application the effect of nuclear shell structure on the level density is estimated. Finally, the influence on the level density of an energy gap in the single fermion spectrum is discussed. It is shown that the introduction of an energy gap can account for the observed difference in level densities of nuclei with odd and even number of nucleons.

530.145

1078. EFFECTIVE RANGE EXPANSION OF THE SCATTERING MATRIX. L.M.Delves.
Nuclear Phys., Vol. 8, No. 3, 358-73 (Oct. [1], 1958).

The scattering matrix for the general N-channel reaction is diagonalized in the channel spin representation, and the eigen-phase-shifts and elements of the diagonalizing matrix are expanded in a power series about an arbitrary energy. Methods are given for calculating the coefficients in the series from numerical solutions of the wave equation, thus giving a complete generalization of the usual effective range theory to N-channel systems.

530.145

1079. SOME PROBLEMS ENCOUNTERED IN THE THEORY OF THE DISPERSION RELATIONS. A.A.Logunov and A.N.Tavkhelidze.
Nuclear Phys., Vol. 8, No. 3, 374-93 (Oct. [1], 1958).

Dispersion relations are obtained for a reaction involving a variable number of particles (a fermion and boson prior to the reaction and a fermion and two identical bosons after the reaction). Cases are indicated for which an unobservable energy region is absent in the dispersion relations. A justification of the dispersion relations in the absence of an unobservable energy region is presented for the particular process $\gamma + p \rightarrow 2\gamma + p$.

530.145

1080. ON THE ELEMENTARY PARTICLES AND THEIR STRONG INTERACTIONS. W.Królikowski.
Nuclear Phys., Vol. 8, No. 4, 461-7 (Oct. [2], 1958).

In this paper a local theory of elementary particles is proposed. Types of fermions following from this theory seem to cover exactly the list of experimental baryons and leptons. The general expressions for the charge and strangeness operators are given. Some preliminary propositions are made for the form of strong interactions.

530.145

1081. EQUATION FOR VERTEX PART CORRESPONDING TO FERMION—FERMION SCATTERING. K.Ter-Martirosyan.
Phys. Rev., Vol. 111, No. 3, 948-50 (Aug. 1, 1958).

A system of equations is deduced whereby the vertex operator for fermion—fermion scattering and the Green's function are expressible in terms of the sum of contributions from a subset of all irreducible diagrams for the process.

530.145

1082. VARIATIONAL METHODS IN SCATTERING PROBLEMS. M.Moe and D.S.Saxon.
Phys. Rev., Vol. 111, No. 3, 950-7 (Aug. 1, 1958).

Modifications of the Hulthén—Kohn variational principle are introduced for the purpose of increasing the usefulness of variational methods. Although no simple formulation of general utility is found, it is shown that there exists a great variety of stationary expressions which make possible a greater freedom in the choice of variational principles than has hitherto been demonstrated. Some criteria for the selection of special forms are discussed.

530.145

1083. SCATTERING AMPLITUDES FOR THE THIRRING MODEL. F.L.Scarf.
Phys. Rev., Vol. 111, No. 5, 1433-5 (Sept. 1, 1958).

The lowest-order covariant equation for the two-particle scattering amplitude in the Thirring model is derived and solved. The results are compared with the exact amplitude, which can be computed by means of Glaser's techniques. The approximate equation contains many spurious solutions which have reasonable asymptotic behaviour. Furthermore, some important features of the exact results are not reproduced in any of the ladder-approximation amplitudes.

530.145

1084. MINIMUM THEOREM FOR THE INTERACTION RADIUS IN TWO-BODY COLLISIONS. W.Rarita and P.Schwed.
Phys. Rev., Vol. 112, No. 1, 271-2 (Oct. 1, 1958).

A general theorem is derived for the behaviour of a two-body scattering process. It is shown that the phase-shift analysis must incorporate at least $l$ non-negligible phase shifts, where $l$ is determined by the total and elastic cross-sections in a simple fashion. For large $l$, a minimum value for the interaction radius can be inferred from $l$. This result is applied to several scattering experiments which were previously analysed, and the minimum radius obtained turns out in each case to be quite close to the interaction radius as estimated in the more elaborate discussion.

530.145

1085. THE COLLECTIVE TREATMENT OF A FERMI GAS. I. S.F.Edwards.
Proc. Phys. Soc., Vol. 72, Pt 5, 685-93 (Nov., 1958).

The collective approach to a Fermi gas is discussed by considering the wave-functions of non-interacting Fermi gases in one and three dimensions, and of the interacting Fermi gas. It is shown how to write the one-dimensional case exactly in terms of collective coordinates, and how these have a well-defined existence for long wavelengths even without interaction. This is extended as far as possible to three dimensions, and it is shown how the statistics

affect the collective motion in the presence of interaction. A brief discussion is given of how calculations may be performed when redundant sets of coordinates are used.

530.145 : 539.2

1086. ENERGY SPECTRUM OF A HIGH DENSITY ELECTRON GAS. Chén' Chun'-Syan' and Chzhou Si-Shin'.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1566-73 (1958). In Russian.

A special class of diagrams corresponding to the diverging terms in the usual perturbation theory expansion for a system with Coulomb interaction (infrared divergence) is summed by the second quantization procedure. An energy spectrum for a high-density electron gas is derived which contains individual excitations (quasi-particles obeying Fermi statistics), as well as collective excitations of the plasma type. The correction to the heat capacity due to appearance of self-energy of the elementary excitations is computed. The results are compared with those of Gell-Mann and Brueckner. To a certain extent the results can be considered as a justification of the independent particle model in the electron theory of metals.

530.145

1087. REPRESENTATION OF FORMS IN $\psi$ AND $\psi^c$. D.Ruelle.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 44, No. 5, 466-71 (1958). In French.

The well-known bilinear forms $\bar{\psi}O\psi$, generalized to include $\psi^c$ as a factor, are written with the help of Gürsey's wave matrices. The assumption is made that $\psi$ anticommutes with $\bar{\psi}$, as well as with itself. Some identities are also derived.

530.145 : 539.19

1088. ON THE APPROXIMATE CALCULATION OF EIGENFUNCTIONS. B.F.Gray.
J. chem. Phys., Vol. 29, No. 6, 1246-7 (Dec., 1958).

A method is given for determining the variable parameters in trial wave-function which is independent of the minimum energy criterion. The energy is given as the root of a secular equation, but the value obtained may be above or below the true value. It is shown that the results of the method approach those of the standard one as the trial function becomes a better approximation to the true one, by applying it to the series of two-electron ions.

530.145

1089. QUANTUM-MECHANICAL KINETIC ENERGY TRANSFORMATION. A.J.Freeman and P.O.Löwdin.
Phys. Rev., Vol. 111, No. 5, 1212-13 (Sept. 1, 1958).

It is shown that by a transformation of the usual expression for the kinetic energy matrix elements a simpler formula results which yields, for numerical wave-functions, higher numerical accuracy for the kinetic energy than has previously been obtained. The derivation of the transformation and the numerical results of several applications are presented.

530.145

1090. VARIATIONAL APPROACH TO THE MANY-BODY PROBLEM. R.U.Ayres.
Phys. Rev., Vol. 111, No. 6, 1453-60 (Sept. 15, 1958).

Certain problems connected with the choice of trial variational functions for the quantum many-body problem are discussed. It is convenient to make use of the reduced-density-matrix formulation developed by Löwdin and Mayer, since a system whose Hamiltonian contains only 1- and 2-body interactions is characterized by the two simplest reduced density matrices $\Gamma^{(1)}$ and $\Gamma^{(2)}$. It is known that symmetry, Hermiticity, and normalizability conditions are not sufficient to ensure a physically realizable choice of the functions $\Gamma^{(1)}$ and $\Gamma^{(2)}$. However an additional non-trivial restriction is imposed by the fact that such functions must be possible variational extrema. The implications of this condition are investigated in some detail and it turns out that all the nonphysical choices of $\Gamma^{(1)}$ and $\Gamma^{(2)}$ which have been exhibited by various authors are eliminated. The condition is essentially non-quantum inasmuch as an analogous argument should be possible for a classical system. Moreover one of the consequences of this condition is that the system (classical or quantum) may exhibit macroscopic behaviour, i.e. order-disorder transitions. The analysis leads to apparently reasonable choices of trial forms for $\Gamma^{(1)}$ and $\Gamma^{(2)}$, although it is still not known whether any further restriction must be imposed to complete the sufficiency argument.

530.145

1091. ON THE APPLICATION OF THE TAMM–DANCOFF METHOD IN THE QUANTUM THEORY OF NON-LINEAR WAVE EQUATIONS. K.Ladányi.
Z. Naturforsch., Vol. 13a, No. 10, 906-8 (Oct., 1958). In German.

Several propositions are made to improve, by the use of variational techniques, the Tamm–Dancoff type of quantization method, employed by Heisenberg to solve the non-linear spinor field equation.

P.Roman

530.145

1092. SUPER-BARRIER REFLECTION IN THE QUASI-CLASSICAL APPROXIMATION. V.L.Pokrovskiĭ, S.K.Savvinykh and F.R.Ulinich.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1272-7 (1958). In Russian.

The asymptotic expression for the reflection coefficient from a one-dimensional potential barrier was found for the case when the wavelength is much smaller than the characteristic dimensions of the barrier.

530.145

1093. SUPER-BARRIER REFLECTION IN THE QUASI-CLASSICAL APPROXIMATION. II.
V.L.Pokrovskiĭ, F.R.Ulinich and S.K.Savvinykh.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1629-31 (1958). In Russian.

An asymptotic expression for the amplitude of super-barrier reflection throughout the whole region of variation of the parameters $U_0/E$, $k_0a$ is obtained under the condition of the quasi-classical approximation $k_0a \gg 1$ and the condition $(E-U_0)\,k_0a/U_0 \gg 1$.

530.145 : 517.2

META-DERIVATIVES AND ANTICOMMUTATORS.
See Abstr. 977

# STATISTICAL MECHANICS TRANSFER PROCESSES

530.16

1094. ON THE USE OF THE NOTION "PROBABILITY" IN THE PHYSICS. T.Ehrenfest-Afanassjewa.
Amer. J. Phys., Vol. 26, No. 6, 388-92 (Sept., 1958).

An analysis of the meanings of such terms as "at random", "equal chances","probability calculus", "laws of probability" as used in physics.

530.161

1095. ENTROPY, IRREVERSIBLE PROCESSES AND FLUCTUATIONS. S.Teitler and R.F.Wallis.
Physica, Vol. 24, No. 8, 625-31 (Aug., 1958).

The Gibbs and Boltzmann description of a system are contrasted for the entropy of a general Markov process. An H theorem is established for the Gibbs entropy. The master equation for non-stationary processes is introduced to initiate a discussion of the phenomenological equations in the two descriptions. The assumed connection between stationary state fluctuations and irreversible processes is exploited to yield the Nyquist relation for stationary processes.

530.162

1096. NEW LOOK AT VON NEUMANN'S OPERATOR METHOD IN QUANTUM STATISTICS. I. W.Band.
Amer. J. Phys., Vol. 26, No. 7, 440-51 (Oct., 1958).

The statistical interpretation of the Heisenberg uncertainty principle, the definition of mixed ensembles, and the meaning of measurement in quantum mechanics, are discussed. The von Neumann projection operator is explained, and is used to set up the ensemble density matrix and the von Neumann entropy operator.

530.162

1097. STATISTICAL THEORY OF IRREVERSIBLE PROCESSES. I. INTEGRAL OVER FLUCTUATION PATH FORMULATION. D.Falkoff.
Ann. Phys. (New York), Vol. 4, No. 3, 325-46 (July, 1958).

The statistical theory of irreversible processes due to Onsager and Machlup (Abstr. 420/1954) is reformulated in terms of integrals over fluctuation paths. In this form the theory closely parallels Feynman's space-time approach to quantum mechanics. Mathematically the appropriate technique is the Wiener integral. It is shown how the use of these methods makes it possible to ask and answer questions concerning averages over fluctuation paths. The requisite methods are taken from the theory of stochastic processes. The possibility for generalizing the theory to non-Gaussian Markoff processes is indicated. Relations are established between functional integrals over the Ornstein–Uhlenbeck process and Wiener integrals. (A preliminary account was published in Abstr. 5893/1957).

530.162

1098. ON MAYER'S THEORY OF CLUSTER EXPANSIONS. E.E.Salpeter.
Ann. Phys. (New York), Vol. 5, No. 3, 183-223 (Nov., 1958).

New derivations are presented for Mayer's well-known irreducible cluster expansions (in powers of the density) for the fugacity,

for the two-body correlation function and for the n-body correlation function. These derivations are based on the assumption that all the cluster expansions converge (and are thus not suitable for investigating condensation phenomena) but shortcircuit much of the combinatorial algebra encountered in previous derivations, by means of relatively simple topological arguments. An expansion is derived for the two-body correlation function for a system involving long-range but weak two-body forces. The first term of this expansion reduces to the Debye–Hückel theory for the special case of Coulomb forces. This expansion differs slightly from one derived previously by Mayer and the problem of analytic continuation, encountered when proceeding to the Coulomb force, is treated differently. Topological methods are outlined for re-deriving some integral equations of Kirkwood and Salsburg, and of Mayer and Sarolea.

530.162

1099. INFORMATION THEORY AND THE DIVERGENT SUMS IN PHYSICS. L.Brillouin.
Ann. Phys. (New York), Vol. 5, No. 3, 243-50 (Nov., 1958).

The author has previously shown (Abstr. 100, 8072/1954) that there is no actual limit to the small distances that can be measured, but that the cost of the measurement increases enormously when distances become really small. This strongly suggests the introduction of a probability factor in sums containing small distances. Such an attempt is made, and yields a type of summation closely related to the Cesàro sums. The method leads to the definition of a characteristic length $h/2m_0c$ for a particle of mass $m_0$. For an electron this is $\frac{1}{2}$ the Compton length, and the electromagnetic mass is of the order of $\frac{1}{860}$ of the total mass. Divergent sums are made convergent, and convergent sums are very slightly altered. The Lamb–Retherford effect, for instance, should not be affected by this correction, which would however yield a finite electron mass. A computation of orders of magnitude shows that the conditions introduced play an important role for observations at extremely high energies.

530.162 : 530.145

1100. EXTENSION OF THE HARTREE METHOD TO STRONGLY INTERACTING SYSTEMS. J.B.Aviles, Jr.
Ann. Phys. (New York), Vol. 5, No. 3, 251-81 (Nov., 1958).

A trial solution constructed from two-body functions is applied to a variational treatment of the many-body problem with strong forces. The expectation value of the energy for Bose systems is expressed as a series of cluster integrals, which are evaluated and partially summed by techniques resembling those developed for the treatment of the imperfect gas in classical statistical mechanics. The two-body functions are found to satisfy a simple wave equation, which describes the motion of two particles in a field consisting of the actual two-body potential plus an effective potential resulting from collisions with other particles. This equation represents an extension of the Hartree equation to strongly interacting systems. Analytic solutions of a modification of this equation are found for the case of the hard sphere Bose gas at low density, and are shown to give very good agreement with the results of a non-variational calculation by Lee, Huang, and Yang. The method is then extended to Fermi systems. The derivation of the cluster series for fermions requires a substantial modification of the classical methods, and leads to more complex results than those obtained for the Bose systems. The results are applied to the evaluation of the ground-state energy of a gas of hard sphere fermions.

530.162

1101. ON CERTAIN PROBABILITY LAWS WITH EXPONENTIAL WEIGHT IN STATISTICAL MECHANICS.
A.Blanc-Lapierre and A.Tortrat.
C.R. Acad. Sci. (Paris), Vol. 247, No. 1, 35-8 (July, 7, 1958).
In French.

A number of theorems are given for the case when the random variables satisfy a set of linear relations with integer coefficients (a generalization of the case of an ideal gas of identical particles where conservation of energy and number of particles requires two relations). This generalization is said to be applicable to interacting particles of different types. F.Ansbacher

530.162 : 533.7

1102. BASIS OF KINETIC THEORY AND THE BOLTZMANN EQUATION. CASE WHERE THE FLUID IS SUBJECTED TO A FIELD OF FORCE. S.Marquet.
C.R. Acad. Sci. (Paris), Vol. 247, No. 17, 1319-22 (Oct. 27, 1958).
In French.

A system of n particles is supposed, described by a measure of its extension in phase, for which an equation of evolution is established. The equation is solved under certain general conditions, and its properties studied. P.Gray

530.162 : 533.7

1103. BASIS OF KINETIC THEORY AND THE BOLTZMANN EQUATION. CASE WHERE THE FLUID IS SUBJECTED TO A FIELD OF FORCE. S.Marquet.
C.R. Acad. Sci. (Paris), Vol. 247, No. 18, 1445-8 (Nov. 3, 1958).
In French.

See preceding abstract. The Boltzmann equation is generalized to measure space by means of a theorem of eventual stochastic independence, and formally solved for binary collisions.

P.Gray

530.162 : 621-52 : 621.372.52

1104. DYNAMIC PROGRAMMING AND STOCHASTIC CONTROL PROCESSES. R.Bellman.
Information and Control, Vol. 1, No. 3, 228-39 (Sept., 1958).

Consider a system S specified at any time t by a finite dimensional vector x(t) satisfying a vector differential equation

$$dx/dt = g[x, r(t), f(t)], \quad x(0) = c,$$

where c is the initial state, r(t) is a random forcing term possessing a known distribution, and f(t) is a forcing term chosen, via a feedback process, so as to minimize the expected value of a functional

$$J(x) = \int_0^T h(x - y, t)\, dG(t),$$

where y(t) is a known function, or chosen so as to minimize the functional defined by the probability that $\max_0 \le t \le T\ h(x - y,t)$ exceed a specified bound. It is shown how the functional equation technique of dynamic programming may be used to obtain a new computational and analytic approach to problems of this genre. The limited memory capacity of present-day digital computers limits the routine application of these techniques to first and second order systems at the moment, with limited application to higher order systems.

530.162

1105. ENTROPY PRODUCTION IN IRREVERSIBLE MECHANICAL PROCESSES. D.H.Everett.
Nature (London), Vol. 182, 1084-5 (Oct. 18, 1958).

It is pointed out that the entropy production associated with an irreversible mechanical process can often be associated with the process of temperature equalization, after some local heating has occurred as a result of a primary process. P.T.Landsberg

530.162

1106. PATH DISTRIBUTION FOR IRREVERSIBLE PROCESSES. H.B.Callen.
Phys. Rev., Vol. 111, No. 2, 367-72 (July 15, 1958).

An expression is derived which gives the probability of any specified response of a driven linear dissipative system. The probability that a system driven by a force $V_i(t)$ will follow an irreversible path taking it through the neighbourhood of $\tilde{Q}_k$ at time t is

$$P(\tilde{Q}_k,t) = P_0(\tilde{Q}_k)\, \exp\left(\beta \int_{-\infty}^{t} dt'\ V_i(t') \left\langle \frac{d}{dt}\tilde{Q}_i(t-t') \right\rangle_{\tilde{Q}_k(0)}\right),$$

where $P_0(\tilde{Q}_k)$ is the equilibrium distribution function, and the last factor is the mean value in the equilibrium ensemble of $d\tilde{Q}_i/dt$ at time t−t', conditional on $\tilde{Q}_k$ at time zero. The path distribution function above is the classical ($\hbar \to 0$) approximation to the quantum-mechanical distribution, in which $\beta \equiv 1/kT$ is replaced by a somewhat more complicated form. The mean square path deviation is found.

530.162

1107. RECURRENCE TIME OF A DYNAMICAL SYSTEM.
P.C.Hemmer, L.C.Maximon and H.Wergeland.
Phys. Rev., Vol. 111, No. 3, 689-94 (Aug. 1, 1958).

Poincaré cycles of a many-particle system are exemplified by the motion of a linear chain. It is shown that the recurrence time increases in an approximately exponential way with the number of degrees of freedom, and as a power of sharpness with which the recurrent state is specified. An explicit formula is given which is applicable to other separable dynamic systems as well.

530.162

1108. ON THE ERGODIC HYPOTHESIS AND THE CONCEPT OF MACROSCOPIC OBSERVABLES. G.Ludwig.
Z. Naturforsch., Vol. 12a, No. 8, 662-3 (1957). In German.

The use of the concept of macroscopic observables, which is usually invoked in justification of the ergodic hypothesis, is discussed very briefly and a sharp distinction is made between ergodic and macroscopic observables. T.R.Carson

530.162

1109. CONCERNING GIBBS' CANONICAL DISTRIBUTION FUNCTION. R.Kurth.
Z. Naturforsch., Vol. 13a, No. 1, 30-2 (Jan., 1958). In German.

Although the canonical distribution function of Gibbs appears to be quite artificial it gives correct results. The underlying reason in classical statistics is shown to be that it appears as a limiting form for the phase-space distribution of an assembly of a large number of particles whatever the underlying marginal distributions of the individual particles. R.O.Davies

530.19

1110. THE LAPLACE TRANSFORM METHOD FOR PROBLEMS OF RADIATIVE TRANSFER. II. MILNE'S PROBLEM WITH NON-COHERENT SCATTERING. S.Ueno.
Ann. Astrophys., Vol. 21, No. 2, 71-6 (1958).

For previous part see Abstr. 4771 (1958). The law of darkening is established for Milne's problem in a half-space (with non-coherent and isotropic scattering) from the Laplace transform of the Milne first integral equation.

530.19 : 517.947.44 : 621-52 : 621.372.6

1111. SUBHARMONICS OF ANY ORDER IN NONLINEAR SYSTEMS OF ONE DEGREE OF FREEDOM: APPLICATION TO SUBHARMONICS OF ORDER $\frac{1}{3}$. D.G.Magiros.
Information and Control, Vol. 1, No. 3, 198-227 (Sept., 1958).

The subharmonics of any order are discussed for the case where the non-linearity enters in the elastic forces. The basic differential equation is,with coefficients,not necessarily small. The "steady state" and "transient" solutions of the differential equation, and the conditions for the existence of the subharmonics and their stability in a steady state are examined. The theory is applied to an investigation of the subharmonics of order $\frac{1}{3}$. An illustrated example is given, the "inverse problem" is examined, and the conditions for the stability and instability of the "harmonic solution" are found.

530.19 : 538.56 : 535.13 : 534.23

1112. TOROIDAL WAVE FUNCTIONS. V.H.Weston.
Quart. appl. Math., Vol. 16, No. 3, 237-57 (Oct., 1958).

The Helmholtz equation is solved in toroidal coordinates. A complete set of solutions is obtained representing radiations from a ring source.

# GENERAL MECHANICS MECHANICS OF SOLIDS

531.12 : 530.12

POSTULATES COMMON TO CLASSICAL AND RELATIVISTIC KINEMATICS. See Abstr. 1031

531.23

1113. GRAPHICAL ANALYSIS OF THE MOMENT OF INERTIA EXPERIMENT. F.W.Van Name, Jr.
Amer. J. Phys., Vol. 26, No. 9, 605-6 (Dec., 1958).

A graphical method for eliminating the effect of friction in moments of inertia experiments is described. A typical set of data is presented. The improvement in accuracy obtained by this method is shown, as compared to the value obtained when friction is neglected.

531.258

1114. ELASTICITY AND PLASTICITY. F.A.V.Meinesz.
Appl. sci. Res. A, Vol. 6, No. 2-3, 205-25 (1956).

A semi-graphical analysis of local stress and strain, with an application to plastic deformation of a plate in a state of plane stress J.G.Oldroyd

531.258

1115. THERMAL STRESSES IN A PLATE CONTAINING TWO CIRCULAR HOLES OF EQUAL RADIUS, THE BOUNDARIES OF WHICH ARE KEPT AT DIFFERENT TEMPERATURES.
C.A.M.van der Linden.
Appl. sci. Res. A, Vol. 6, No. 2-3, 117-28 (1956).

Calculations of stresses in an infinite plane, containing two circular holes, can be performed by means of bipolar coordinates. In the case considered, the stresses are caused by the difference in temperature of the boundaries of the holes. A method is given to calculate the stresses and the strains. The calculation of the stresses is performed for a particular case.

531.259.2 : 535.417

1116. MEASUREMENTS OF QUENCHING STRESSES IN A BEARING RING BY INTERFERENCE FRINGES.
T.Mura and H.Yoshimoto.
J. appl. Phys., Vol. 29, No. 2, 115-19 (Feb., 1958).

Measurements were made for quench induced residual stresses in a ring of bearing steel. The stress distributions vary along the radial direction r and the axial direction z. The mean values of the axial stresses depend on r only and were obtained previously. The deviations of the residual stresses from the mean as a function of z are found at two radii. An interferometric method was used to detect the deflections of the ring, and the spatial variation is obtained by etching one surface in uniform steps. The stress distributions obtained had typical residual stress shapes, and were compression near the surfaces and tension in the middle. In a ring the mean values do not vanish, but the deviations from the mean are found to be small compared to the mean values. This indicates that the radial temperature gradient dominates in determining the stress distribution, regardless of the size of the axial temperature gradient.

531.3

1117. NOTE ON THE MOTION OF BODIES WITH LARGE VELOCITIES IN A WEAK FIELD OF GRAVITY. K.P.Stanyukovich.
Dokl. Akad. Nauk SSSR, Vol. 120, No. 2, 277-80 (1958). In Russian.

The equations of motion are derived in the case of adiabatic flow with central symmetry, using the equation of state of the medium and neglecting the electromagnetic field. The case of an exploding gas, under the influence of its own gravitational field and when its internal pressure has become small, is studied in detail. M.J.Kearsley

531.532

1118. EXPERIMENTS WITH MODIFIED FORM OF SIMPLE PENDULUM. J.W.Fox.
Amer. J. Phys. Vol. 26, No. 8, 559-60 (Nov., 1958).

A bob is hung by a Y- or V-shaped thread and oscillates in a plane normal to that defined by the equilibrium position of the thread. A variation of period is achieved by moving apart the two points of suspension. Simple theory is given and is illustrated by experimental results.

# MECHANICAL MEASUREMENTS

531.787.2

1119. PRESSURE-SENSITIVE DIAPHRAGM-TYPE NULL DETECTOR. D.White and J.Hilsenrath.
Rev. sci. Instrum., Vol. 29, No. 7, 648-51 (July, 1958).

The device, which is particularly suited to working with corrosive substances, has a high sensitivity, a reproducible null under ordinary operating conditions, and a small dead-space volume (approximately 0.01 $cm^3$). Pressure unbalance of 0.3 to 0.5 mm Hg causes a thin (0.001 in.) metallic diaphragm to make or break electrical contact with an insulated probe. The above differentials are detectable at pressures of 200 atm. The diaphragms require no special fabrication, and can withstand moderate overpressure on one side without affecting the diaphragm or its sensitivity.

531.788

1120. A NEW DOUBLE SPOON GAUGE. J.D.Swanwick.
J. Chem. Soc., 1958, 3214-15 (Sept.).

The operation of the instrument is clearly described, and is based on the use of one gauge as fulcrum of a pointer of large mechanical advantage to which the other is applied. The sensitivity is sufficient to measure pressure differences of $10^{-3}$ mm Hg, and the instrument is more robust than single gauges. P.Gray

# MECHANICS OF FLUIDS

532.122

1121. STUDY OF THE COMPRESSIONS OF SEVERAL HIGH MOLECULAR WEIGHT HYDROCARBONS.
W.G.Cutler, R.H.McMickle, W.Webb and R.W.Schiessler.
J. chem. Phys., Vol. 29, No. 4, 727-40 (Oct., 1958).

Isothermal compressions were measured for thirteen high purity liquid hydrocarbons and two binary mixtures of liquid hydrocarbons. These hydrocarbons have a molecular weight range of 170 to 351 and included normal paraffins, cycloparaffins, aromatics,

and fused ring compounds. The pressure range for these measurements was from atmospheric to as high as 10 000 bars, being limited to lower values for some compounds to avoid possible solidification of the liquid. The volume changes due to pressure were measured at six temperatures spaced about equally in the range 37.8°C to 135.0°C. The volume changes and pressures were measured by methods similar to those of Bridgeman. Pressure–volume isotherms can be described adequately by the Tait equation, $v_0 - v = C \log (1 + P/B)$, or for pressures above a certain minimum, whose value depends on the compound, by the Hudleston equation

$$\log [v^{2/3}P/(v_0^{1/3} - v^{1/3})] = A + B(v_0^{1/3} - v^{1/3}).$$

For the Tait equation the parameter C can be predicted for hydrocarbon liquids from the relation $C = 0.2058\ v_0$. Compressibility for a given hydrocarbon decreases with increasing pressure at constant temperature and increases with increasing temperature at constant pressure. The compression, and the compressibility, of liquid hydrocarbons are strongly dependent on molecular structure. Cyclization introduces a rigidity of molecular shape which decreases the compressibility markedly. Furthermore, fused ring cyclization as exemplified by naphthyl and decalyl structures has a considerably greater effect in decreasing compressibility than cyclization to nonfused rings such as cyclopentyl, cyclohexyl, or phenyl, even at equivalent carbon atom in ring percentages. Isobars and isochores were drawn and studied over the full range of temperature and pressure. The coefficient of thermal expansion, $(1/v_0)(\delta v/\delta T)_P$, for a given hydrocarbon, decreases with increasing pressure at constant temperature. $(\delta^2 v/\delta T^2)_P$ undergoes a sign change at a certain pressure, whose value depends on the compound; $(\delta v/\delta T)_P$ increases with increasing temperature below this pressure and decreases with increasing temperature above this pressure. The pressure coefficient, $(\delta P/\delta T)_V$, is not a function of volume alone but is also dependent on the temperature and pressure. $(\delta E/\delta v)_T$ and $(\delta E/\delta P)_T$ go to zero and then reverse sign for compounds that can be studied to sufficiently high pressures.

532.13

1122. THE DETERMINATION, BY A VIBRATION METHOD, OF THE DEPENDENCE OF THE VISCOSITY OF LIQUIDS UPON PRESSURE. M.Krötzsch.
Exper. Tech. der Phys., Vol. 5, No. 3, 116-28 (1957). In German.

A hollow iron cylinder, which is suspended in a pressurized liquid between two helical springs,is deflected magnetically. On removing the magnetic field the cylinder vibrates, and the rate of decrease in amplitude depends upon the viscosity of the liquid. For a comparison with results obtained by Bridgman, an empirical viscosity–pressure and temperature relationship was used for pressures up to 2000 atm. R.Schnurmann

532.13

1123. EFFECT OF PRESSURE ON VISCOSITY OF HIGHER HYDROCARBONS AND THEIR MIXTURES.
E.M.Griest, W.Webb and R.W.Schiessler.
J. chem. Phys., Vol. 29, No. 4, 711-20 (Oct., 1958).

Using the rolling-ball method the viscosity of seven pure hydrocarbons, having 25 or 26 carbon atoms, and three binary mixtures of them was measured to 3450 bars at 37.8°, 60.0°, 98.8°, and 135°C. The compounds included isoparaffinic, cycloparaffinic, and aromatic types. The increase in viscosity with pressure was found to be strongly dependent on molecular structure. The viscosity–temperature coefficient $1/\eta(\partial\eta/\partial T)_P$ increased with increased pressure while the viscosity–pressure coefficient $1/\eta(\partial\eta/\partial P)_T$ decreased with increased temperature. The behaviour of the binary mixtures corresponded within 5% over a range of 50-100 fold change in viscosity to that of the pure compounds equivalent to them in molecular weight and average molecular structure. This remarkable agreement is interpreted to mean that the viscosity of these compounds is some additive function of their constituent groups whether these groups are combined in the same or different molecules as long as the basic molecular symmetry is unchanged. The values of the Eyring theory $\Delta F_\pm$, $\Delta H_\pm$, $\Delta S_\pm$, and $\Delta V_\pm$ for these data are discussed. For the saturated compounds at constant temperature, an approximately linear relation was found between $\log \eta$ and $[(v/v_0)^4 = (v/v_0)^2]$ where v is the specific volume and $\eta$ the absolute viscosity.

532.133

1124. CORRECTION TO THE VISCOELECTRIC CONSTANT.
J.Hart.
J. chem. Phys., Vol. 29, No. 4, 960-1 (Oct., 1958).

Previously published calculations of the effect of an electric field on the viscosity of polar liquids, from measurements by Dodd's method (Abstr. 1099/1949, 1637/1951, 3158, 10839/1954), are corrected by reassessing the effect of dielectric heating. Errors of the order of 25% in the viscoelectric constant are usual; and the viscoelectric effect is now found not to increase with frequency, but to be negligible at high audio-frequencies. J.G.Oldroyd

532.133

1125. THE VISCOSITY OF DILUTE SUSPENSIONS OF THREAD-LIKE PARTICLES. M.A.Nawab and S.G.Mason.
J. phys. Chem., Vol. 62, No. 10, 1248-53 (Oct., 1958).

The viscosity of dilute suspensions of thread-like rayon particles was measured for various values of the axis ratio r, and the intrinsic viscosity $\alpha_0$ compared with various theoretical equations. No good agreement with theory was found, but evidence is presented to show that the intrinsic viscosity is sensitive to a mean particle-orientation factor, which is in turn sensitive to permanent and recoverable deformation of the particles by the velocity gradient, and that Burger's equations probably could be corrected for this effect so as to give agreement of $\alpha_0$ with experiment. For values of r up to 240, $\alpha_0$ was independent of the velocity gradient G. The reduced viscosity at finite concentrations, on the other hand, was independent of G only when $r \leq 113$. Suspensions of $r > 113$ showed the Weissenberg effect, probably due to elastic deformation of the threads by the gradient. Plasticizing the fibres with water caused a marked increase in $\alpha_0$ at high values of r, probably due to increased bending of the fibres. A simple exponential relationship has been found between $\alpha_0$ and the interaction coefficient $\alpha_1$.

532.133

1126. THE VISCOSITY OF DILUTE EMULSIONS.
M.A.Nawab and S.G.Mason.
Trans Faraday Soc., Vol. 54, Pt 11, 1712-23 (Nov., 1958).

The viscosity of a series of dilute monodisperse oil–water emulsions having ratios of viscosity of disperse to continuous phases varying from 0.5 to 5.2 was measured as a function of emulsion concentration, and the intrinsic viscosity $\alpha_0$ and the interaction coefficient $\alpha_1$ were determined in the Newtonian region. In a number of cases, the measured $\alpha_0$ was in excellent agreement with that calculated from Taylor's hydrodynamic theory which makes allowance for the effect of circulation inside the emulsion droplets. In other cases, including a series of emulsions of butyl benzoate in aqueous gylcerin solutions containing a non-ionic emulsifier, and a series in water containing an anionic emulsifier to which traces of a precipitating electrolyte were added, $\alpha_0$ was greater than the theoretical value. It was concluded from these experiments that Taylor's theory was valid except when an interfacial film was formed by the emulsifying agent which tended to inhibit internal circulation. Oldroyd's recent extension of Taylor's theory was used to calculate a linear combination of the two-dimensional shear and dilatational viscosity coefficients of films causing deviation from Taylor's theory. When Taylor's theory applied, $\alpha_1$ increased with increasing $\alpha_0$ up to $\alpha_0 = 2.5$ for rigid spheres according to a simple exponential relationship. When the system deviated from the theory, a more complicated relationship involving factors other than $\alpha_0$ was indicated.

532.137

1127. A ROTATIONAL VISCOMETER EMPLOYING A REFERENCE LIQUID. J.F.Hills.
J. sci. Instrum., Vol. 35, No. 11, 415-18 (Nov., 1958).

The viscometer described is a rotational one in which a free rotor is accelerated by the torque transmitted through a reference liquid by a driven rotor, and retarded by the torque acting through the liquid under test which is restrained by a stator. The free rotor thus attains an equilibrium speed of rotation. The ratio of the rates of the driven and free rotors is a linear function of the viscosity being measured, and, apart from a negligible effect of bearing friction, is independent of the absolute rotational speed of the driven rotor when using Newtonian liquids. The theory of the viscometer is given together with an account of an experimental verification. A discussion of the practical application of the instrument includes a study of the accuracy obtainable, and it is shown that with one instrument a viscosity range of 1000 : 1 may be obtained for which the maximum error does not exceed approximately ±0.5% of the measured viscosity for a single test. For error limits of ±0.2% the range is 30 : 1. A feature of the viscometer is that it readily lends itself to the provision of a simple digital "read-out" in any required units.

532.137

1128. A MODIFIED METHOD FOR MEASURING SURFACE VISCOSITY. R.Bulas and C.A.Kumins.
J. Colloid Sci., Vol. 13, No. 5, 429-40 (Oct., 1958).

The oscillating disk method for measuring the surface viscosity was used without recourse to a reference liquid. It was found that

for a pure liquid the logarithmic decrement obtained with the disk positioned in the liquid is twice as large as that obtained with the disk oscillating at the surface of the liquid, provided the distance from the disk to the surface of the liquid and to the bottom of the container is greater than a critical distance $h_c$. A method of determining the critical distance is described and an equation describing the relationship between $h_c$ and the bulk viscosity of the solution is presented. The results obtained in the determination of surface viscosity using this method are shown, and are compared with those obtained with the conventional technique using an external standard.

532.137

1129. CAPILLARY VISCOMETER FOR HIGH-TEMPERATURE MEASUREMENTS OF POLYMER SOLUTIONS.
G.D.Patterson, Jr and L.H.Rabouin, III.
Rev. sci. Instrum., Vol. 29, No. 12, 1086-8 (Dec., 1958).

An all-glass capillary viscometer is described which permits dissolving polymers at high temperatures, filtering, and measuring the solvent and solution efflux flow times without removal from a vapour bath. The advantages include safe handling of liquids at high temperatures without the precipitation or oxidative-degradation difficulties normally encountered in other methods of measuring polymer solution viscosities at elevated temperatures.

532.517

1130. ON THE SLOW STEADY MOTION OF AN INFINITE VISCOUS LIQUID DUE TO THE ROTATION OF A CYLINDER.
S.R.Khamrui.
Bull. Calcutta Math. Soc., Vol. 49, No. 2, 61-6 (June, 1957).

532.517

1131. ON THE FLOW OF A VISCOUS LIQUID THROUGH A TUBE OF ELLIPTIC SECTION UNDER THE INFLUENCE OF A PERIODIC PRESSURE GRADIENT. S.R.Khamrui.
Bull. Calcutta Math. Soc., Vol. 49, No. 2, 57-60 (June, 1957).

532.517

1132. ON THE FLOW OF A VISCOUS LIQUID THROUGH A TUBE OF ELLIPTIC SECTION UNDER EXPONENTIAL PRESSURE GRADIENT. S.R.Khamrui.
Bull. Calcutta Math. Soc., Vol. 49, No. 3, 147-52 (Sept., 1957).

532.517.2

1133. FRICTIONAL LOSSES OF HEAD IN STEADY UNIFORM FLOW. P.G.Franke.
J. sci. industr. Res., Vol. 17B, No. 8, 289-96 (Aug., 1958).

The known equations for the flow of liquids under streamline and turbulent conditions are discussed, and the application of equations developed by Kármán–Prandtl, White–Colebrook and Supino, for determining the coefficient of resistance when fluids flow under pressure through pipes and galleries, is explained. Based on the analogy of partly filled lines of circular cross-sections, formulae for flow in open channels are derived. A table of exponents used in these formulae is presented. Recent researches in the field are reviewed and further lines of work are indicated.

532.517.4

1134. FLOW ANISOTROPY IN THE THEORY OF LIQUIDS.
J.V.Champion.
Proc. Phys. Soc., Vol. 72, Pt 5, 711-16 (Nov., 1958).

From the theory of Eisenschitz (Abstr. 885/1949) on the steady non-uniform state of a liquid, a magnitude was calculated for the anisotropy of flow in a liquid due to a distortion of the radial distribution function by a shearing force. The optical anisotropy was obtained by using the Bragg (Abstr. 1754/1924) method of calculating double refraction from the variation of the polarization due to the distorted distribution function. The value $\Delta n = 7.1 \times 10^{-8}$ (calculated for chloroform, for which the distribution function is known and of which the polarizability does not differ greatly from that of carbon tetrachloride) shows that the effect may be detected experimentally in a liquid normally isotropic. The calculation also shows that the main contribution to the anisotropy arises from small values of the range r, and the magnitude of the anisotropy is independent of the precise way in which the distortion decreases at large distances. This implies that the "strong" condition of Eisenschitz cannot be supported by an appeal to the isotropy of flow.

532.517.4

1135. RELATION BETWEEN TIME SYMMETRY AND REFLECTION SYMMETRY OF TURBULENT FLUIDS. W.C.Meecham.
Phys. of Fluids, Vol. 1, No. 5, 408-10 (Sept.-Oct., 1958).

An assumption of statistical reflection symmetry is proposed for certain turbulent flows. On the basis of this assumption it is shown that some space–time velocity correlations characterizing the flow are even functions of the time delay between the correlation measurements. In particular the second- and one of the fourth-order velocity correlations are symmetric in this relative time.

532.517.4

1136. ON THE MATHEMATICAL STRUCTURE OF TURBULENCE. J.Bass.
Rev. mod. Phys., Vol. 30, No. 3, 1084-5 (July, 1958).

The non-linear equation $u_t + uu_x = \frac{1}{2}u_{xx}$, introduced as a model for turbulence by Burgers, can be reduced to linear form by the substitution $u = -z_x/z$. This leads to a heat conduction equation for z, so that one can write down explicit solutions of the non-linear equation. Another model for turbulence, based on a function of t which jumps irregularly between the values +1 and −1, is mentioned. The intention is to construct explicitly functions u(t) whose time averages and autocorrelation functions are qualitatively similar to those observed in turbulence. O.Penrose

532.517.4

1137. DRAG UNIT FOR THE ARTIFICIAL GENERATION OF TURBULENT SHEAR FLOW. H.G.Elrod.
Rev. sci. Instrum., Vol. 29, No. 9, 762-4 (Sept., 1958).

The "drag unit" is a device capable of generating turbulent shear flows of prescribed time–mean velocity distribution. It can be used as a research tool to study features of turbulence or to ascertain the effects of flow non-uniformities. Typical experimental results are presented.

532.517.4 : 536.2

HEAT TRANSFER IN TURBULENT TUBE FLOW. See Abstr. 242

532.570.8 : 538.5

1138. INDUCTION FLOWMETER. V.Cushing.
Rev. sci. Instrum., Vol. 29, No. 8, 692-7 (Aug., 1958).

The electric field induced in a medium moving relative to a magnetic field is proportional to the intensity of the magnetic field and to the relative velocity of the medium. When applied to media of arbitrary electrical conductivity and dielectric constant, it is seen that any potential difference that arises in connection with the induced electric field is attenuated by the shunting effect of the permittivity of free space. For most media this shunting effect is negligible; for media of extremely low conductivity, however, the effect is appreciable. The effect of the electrical properties of the containing pipe is investigated.

532.582.81

1139. SURFACE WAKE OF A SUBMERGED SPHERE. C.Eckart.
Phys. of Fluids, Vol. 1, No. 6, 457-61 (Nov.-Dec., 1958).

Deals with the problem of a sphere moving in a semi-infinite homogeneous incompressible liquid with a free surface. It is shown that the surface wake of such a submerged sphere is approximately the same as that which would be caused by a travelling pressure disturbance in the atmosphere above the free surface. This is, essentially, a consequence of the Bernoulli theorem. If the motion is sufficiently slow, the surface reacts to this equivalent pressure as a barometer (equilibrium theory). For more rapid motions, dynamic effects reduce the response of the surface, but leave a wake in the region already traversed by the sphere. The calculation of this wake involves the usual distinction between incoming and outgoing waves, which is introduced in the Fourier transform of the solution. The resulting integrals are evaluated by Kelvin's approximate method of stationary phase.

532.584

1140. THE PNEUMATIC CONVEYING OF SPHERES THROUGH STRAIGHT PIPES. J.A.Hitchcock and C.Jones.
Brit. J. appl. Phys., Vol. 9, No. 6, 218-22 (June, 1958).

Two equations were established experimentally which give the pressure gradient and solid velocity along a pipe when non-adhesive spherical particles (up to 7 mm in diameter) are being conveyed with little or no acceleration by an airstream through the pipe. Straight, smooth and horizontal pipes (up to 7 cm in diameter) are considered. The practical application of the equations is examined, and a successful check of the equations is made with some values of the variables outside the range studied in the present paper.

532.59

1141. A WAVEGUIDE FOR SURFACE WAVES ON LIQUIDS.
O.Preining.
Acta. phys. Austriaca, Vol. 12, No. 2, 172-86 (1958). In German.

Parallel vertical strips of thin sheet, fixed in an ideal inviscid fluid, are shown to affect possible surface wave patterns in the same

way as electromagnetic wave patterns can be controlled by waveguides. The theory is tested experimentally by observing wave patterns on water by a modified schlieren photographic method. Refraction effects are observed when a series of parallel strips are assembled so as to form a "prism" for water waves, and the discrepancies between theory and experiment are attributed to the viscosity and no-slip boundary conditions in the real fluid, which are ignored in the idealized theory. J.G.Oldroyd

532.612.4

1142. THE SURFACE TENSIONS OF LIQUID ARGON AND NITROGEN. D.Stansfield.
Proc. Phys. Soc., Vol. 72, Pt 5, 854-66 (Nov., 1958).

The surface tensions of liquid argon and nitrogen were measured over their complete liquid ranges, from triple point to critical point, using a capillary-rise method. The experimental results are given and compared with values obtained theoretically. Agreement between theory and experiment is not good for temperatures near the critical point.

# MOLECULAR THEORY OF LIQUIDS

532.7 : 530.16

1143. STATISTICAL MECHANICAL THEORY OF TRANSPORT PROCESSES IN LIQUIDS. F.C.Collins and H.Raffel.
J. chem. Phys., Vol. 29, No. 4, 699-710 (Oct., 1958).

The hydrodynamic equations of the transport processes are developed in a form in which the irreversibility appears explicitly in terms of the instantaneous time derivatives of the stresses in a molecular scale nonequilibrium region of a system otherwise at equilibrium. The time derivatives of the stresses are shown to be proportional to the gradients of the properties being transported and to the squares of the transport coefficients. The corresponding time derivatives in the statistical mechanical treatment can be expressed as ensemble averages of molecular interactions using instantaneous values of the molecular pair density functions directly without recourse to time-smoothing with considerable gain in simplicity. Expressions for the transport coefficients are obtained by comparison of the hydrodynamic and statistical mechanical equations for the time derivatives of the dissipative stresses. The resulting hydrodynamic frictional and self-diffusion coefficients turn out to be identical to the experssions for these quantities provisionally suggested by Kirkwood, Buff, and Green. Relatively simple expressions are also obtained for the shear and volume viscosity and thermal conductivity coefficients in terms of integrals over space derivatives of the potential energy and the molecular pair density. It is further shown that, if an intermolecular potential of the Lennard-Jones and Devonshire form is assumed, the integrals may be eliminated between these equations and the corresponding statistical mechanical equations for the hydrostatic pressure and the ideal heat of vaporization. This provides simple expressions for the shear viscosity and the thermal conductivity coefficients directly in terms of the latter equilibrium properties. The numerical values obtained for the above two transport coefficients from evaluation of the integrals in the statistical mechanical equations and from the simple expressions in terms of equilibrium properties, are each in comparatively good agreement with experiment.

532.7

1144. RANDOM EVENTS IN A LIQUID. R.E.Turner.
J. chem. Phys., Vol. 29, No. 4, 856-64 (Oct., 1958).

A model is suggested for the evaluation of the time integral of the autocorrelation function for intermolecular forces. This integral plays the part of a "friction constant" in the statistical mechanical theory of transport processes. A cluster of a small number of molecules is regarded as a nonisolated system. By using a self-consistency principle i.e., the identity of the autocorrelation function for all molecules, a fourth-order differential equation is derived, which in principle could be made to give a unique determination of the autocorrelation. Two methods are given for finding an approximate solution. An alternative expression for the autocorrelation function is found by the introduction of "collective" coordinates. Comparison of this expression with the result obtained by the principle of self-consistency leads to a unique determination of the integral of the autocorrelation function. The result has a reasonable physical interpretation for the mechanism of correlation breakdown, namely, the transfer of energy from "collective" motion or sound waves to "individual" or "average" motion.

532.7

1145. CALCULATION OF THE RADIAL DISTRIBUTION FUNCTION FROM THE CELL THEORY OF LIQUIDS. J.S.Dahler.
J. chem. Phys., Vol. 29, No. 5, 1082-5 (Nov., 1958).

A method is given for determining the radial distribution function from the cell theory of liquids. The application of the scheme is demonstrated for two simple choices of the cell distribution function. This technique should prove useful in correlating the observed structure of the radial distribution function with molecular ordering in liquids and in establishing the limitations of the cell model.

532.7 : 534.23

ULTRASONIC ABSORPTION IN LIQUIDS. See Abstr. 146

532.71 : 541.135

IRREVERSIBLE ELECTROCHEMICAL PROCESSES OF MEMBRANES. See Abstr. 905-6

532.72 : 541.15

APPLICATION OF A HIGH-SPEED ELECTRONIC COMPUTER IN DIFFUSION KINETICS. See Abstr. 910

532.73

1146. STRUCTURE IN IONIC SOLUTIONS. III. G.W.Brady.
J. chem. Phys., Vol. 29, No. 6, 1371-5 (Dec., 1958).

For Pt II, see Abstr. 8616 (1958). Measurements of X-ray scattering from ferric chloride solution in the concentration range from 1.5 M to 5 M were made. The radial distributions calculated from these measurements indicate a large degree of local ordering of the ions, with formation of $Fe^{+3} - Cl^-$ complexes. At the highest concentration the $[FeCl_6]^{-3}$ ion appears to be the main species present. As the concentration is lowered the coordination of the $Cl^-$s around $Fe^{+3}$ becomes less definite and other species appear, in particular, the presence of $Fe_2Cl_6$ is indicated.

532.77

1147. ON THE THEOREM OF CORRESPONDING STATES AND ITS APPLICATION TO MIXTURES. S.A.Rice.
J. chem. Phys., Vol. 29, No. 1, 141-7 (July, 1958).

The theorem of corresponding states as applied to mixtures is studied. It is shown that for a solution in which random mixing obtains, it is possible to define reduced temperatures and volumes for each cluster in the cell cluster expansion of the partition function. The relationship of this result to the corresponding states theories of Brown and Kirkwood et al. is considered. In addition the additivity hypothesis of Prigogine is examined and the comments of Salsburg discussed.

532.77

1148. STATISTICAL MECHANICS OF IRREVERSIBLE PROCESSES IN POLYMER SOLUTIONS.
J.J.Erpenbeck and J.G.Kirkwood.
J. chem. Phys., Vol. 29, No. 4, 909-13 (Oct., 1958).

The Kirkwood theory of irreversible processes in polymer solutions is reformulated so as to include all contributions to the frictional forces exerted on the monomer units. The generalized diffusion equation for the nonequilibrium distribution function derived on this basis contains a new perturbation term, dependent upon the external field of force. The solution of this equation may be expressed by a perturbation expansion analogous to that given previously. The general theory is applied to the intrinsic viscosity problem. Although the general theory reverts to the previous one, new techniques are applied which enable the intrinsic viscosity and rigidity to be expressed in terms of the eigenfunctions and eigenvalues of the Oseen interaction tensor and the generalized diffusion operator. Moreover, a second formulation of the viscosity is devised in which the result appears in terms of appropriate time correlation functions.

532.77

1149. N.M.R. AND HYPERFINE INTERACTIONS IN PARAMAGNETIC SOLUTIONS. R.G.Shulman.
J. chem. Phys., Vol. 29, No. 4, 945-7 (Oct., 1958).

It is shown how indirect hyperfine interactions affect n.m.r. properties in a variety of paramagnetic solutions. In particular the resonances are shifted from the normal resonance field of $\psi/\gamma_N$ by hyperfine interactions arising from complex formation with the magnetic ions. These concepts explain the resonance shifts and are useful in understanding the kinetic behaviour, equilibrium constants, and chemical bonding of paramagnetic complexes.

532.77

1150. SMALL PERTURBATIONS IN SOLUTION THEORY.
F.P.Buff and F.M.Schindler.
J. chem. Phys., Vol. 29, No. 5, 1075-81 (Nov., 1958).

A general perturbation theory is developed for the solution properties of systems with comparable intermolecular interactions. By employing earlier general statistical mechanical theory of solutions as a starting point, the dominant contribution to the excess chemical potential is developed rigorously to first and second orders in the perturbation parameters. The very small first-order terms are in agreement with those originally found by Longuet-Higgins and the second-order results may be exhibited in alternative forms. One of these, with use of a physically plausible approximation for the solute–solvent radial distribution function, evaluated in the pure solvent, leads to formulae identical with those of the Prigogine–Scott two-fluid model. Alternatively, this distribution function may be expressed exactly in terms of the pair and triplet correlation function of the solvent. Numerical calculations on the latter, based on liquid argon as reference fluid provide additional support for the successful two-fluid model.

532.77

1151. ON THE STATISTICAL MECHANICAL THEORY OF SOLUTIONS. R.M.Mazo.
J. chem. Phys., Vol. 29, No. 5, 1122-8 (Nov., 1958).

A perturbation expansion of the excess free energy of a binary mixture based on the theory of composition fluctuations in an open system is presented. The theory is applied to classical mixtures and quantum mechanical isotope mixtures, and comparisons with conformal solution theory and Chester's theory of isotope mixtures are made. The advantage of the present theory is that it contains, in summed form, in each order of perturbation, terms which in the direct expansion of the partition function would be considered to be higher order.

532.77 : 537.226.33

DIELECTRIC RELAXATION IN SOLUTIONS WITH LARGE SOLUTE MOLECULES. See Abstr. 280

532.78 : 548.5

NUCLEATION AND GROWTH IN A PHOTOSENSITIVE GLASS. See Abstr. 918

532.771 : 541.135

1152. ULTRASONIC STUDIES ON SOME AQUEOUS SOLUTIONS OF ELECTROLYTES. K.Subba Rao and B.Ramachandra Rao.
J. sci. industr. Res., Vol. 17B, No. 11, 444-7 (Nov., 1958).

The variation of ultrasonic velocity, adiabatic compressibility and apparent molal compressibility with molal concentration was studied in the case of aqueous solutions of seven coloured salts. The experimental results are examined in the light of the Debye–Hückel's theory for electrolytes.

# MECHANICS OF GASES
# VACUUM TECHNIQUE

533.15

1153. ELEMENTARY DERIVATION OF THE MULTICOMPONENT DIFFUSION EQUATION. F.A.Williams.
Amer. J. Phys., Vol. 26, No. 7, 467-9 (Oct., 1958).

It is demonstrated that the multicomponent diffusion equation can be derived from elementary kinetic theory considerations without employing the results of the mathematical theory of non-uniform gases. By using the approach described by Furry (Amer. J. Phys., Vol. 16, 63-78, 1948), elementary expressions for the binary diffusion coefficients are also obtained. The advantage of the concept of the equivalence of partial pressure gradients and momentum gradients is thereby emphasized.

533.15

1154. NOTE ON DIFFUSIVE SEPARATION OF GAS MIXTURES IN FLOW FIELDS. V.C.Liu.
J. appl. Phys., Vol. 29, No. 8, 1188-9 (Aug., 1958).

Discusses the effect of pressure-diffusion flux upon the concentration distribution of gas mixtures in flow fields. The equation of concentration is formulated for a binary gas mixture in which the mass ratio is large and the concentration of the lighter gas is very small. An asymptotic solution to the steady-state equation of concentration is given for an irrotational and incompressible flow. As an illustration, the diffusive separation (i.e. deviation from the original homogeneous state) of a mixture of helium and nitrogen along streamlines at the entrance to a long straight channel is calculated. It is assumed that the pressure inside the channel is 90% of that in the free stream, and that the diffusion coefficient of the mixture corresponds with the atmospheric conditions at 80 km altitude.

533.15

1155. SELF-DIFFUSION IN ARGON TO 300 ATMOSPHERES.
T.R.Mifflin and C.O.Bennett.
J. chem. Phys., Vol. 29, No. 5, 975-8 (Nov., 1958).

The coefficient of self-diffusion for argon is measured from 68 to 291 atm at 49.4°C. A radioactive tracer technique employing $A^{37}$ was used and coefficients measured in a cell in which the path of diffusion was through a plug of porous bronze. Results agree reasonably well with the Enskog dense gas theory calculated from p–v–T data.

533.15 : 537.562

THERMAL DIFFUSION IN IONIZED GASES. See Abstr. 365

533.16

1156. IMPROVED APPARATUS FOR MEASURING THE VISCOSITY OF GASES BY RANKINE'S METHOD.
H.Hart and H.Schirrwitz.
Exper. Tech. der Phys., Vol. 5, No. 4, 173-5 (1957). In German.

The apparatus originally designed by Rankine (Abstr. 649, 888, 1387/1910) is described and modifications are suggested for the avoidance of the defects which have since appeared in practice. The provision of a pre-drying addition is stressed, since the smallest trace of moisture will render the apparatus unusable.

H.H.Hodgson

533.16

1157. VISCOSITY EQUATIONS FOR GAS MIXTURES.
W.E.Francis.
Trans. Faraday Soc., Vol. 54, Pt 10, 1492-7 (Oct., 1958).

A simplified relation between the viscosity of a gas mixture and the viscosities of the individual components is derived from the rigorous kinetic theory equations. The new relation appears to fit the known experimental data with an accuracy of about ±2%, and can be applied to mixtures containing a polar component. The equation was tested on a large number of mixtures of gases of widely differing molecular weights and viscosities, involving considerable departures from the simple mixing rule. The limitations of various equations which have been proposed in the past are discussed, and it is shown that the new equation probably represents the best approximation possible with one of the Sutherland–Thiesen type.

533.16 : 537.543.3 : 545.827

1158. ON THE FRACTIONATION OF GASEOUS SAMPLES IN A MASS SPECTROMETER VISCOUS LEAK.
A.J.H.Boerboom and H.A.Tasman.
Physica, Vol. 24, No. 8, 683-91 (Aug., 1958).

Investigation was made of the fractionation in a mass spectrometer gas inlet system, consisting of a viscous leak connected to the sample reservoir by a long and narrow capillary tube. Graphs are given representing the total fractionation and the time required to approach the stationary state to a certain degree, as a function of the dimensions of the leak and the capillary. The cases treated are 1:1 mixtures of $O_2^{16}$–$O^{16}O^{18}$; $H_2$–$O_2^{18}$; and $H_2$–HD.

533.24

1159. A SMALL HYDROGEN LIQUEFIER.
F.X.Eder, H.Berndt and W.Koeppe.
Exper. Tech. der Phys., Vol. 4, No. 3, 138-41 (1956). In German.

Details are given, with diagram, of the construction and mode of operation of a small hydrogen liquefier having an output of about 2.5 l. liquid $H_2$ per hr. It is suitable for a small factory which requires liquid gases.

H.H.Hodgson

533.5 : 531.788.1

1160. PRESSURE GAUGE FOR CORROSIVE GASES IN THE MICRON AND SUBMICRON REGION. J.R.Anderson.
Rev. sci. Instrum., Vol. 29, No. 12, 1073-8 (Dec., 1958).

For use in the range from $10^{-2}$ to $10^{-5}$ mm Hg. The pressure is indicated by the rate of damping of a hinged silica fibre pendulum, the amplitude of which is measured photoelectrically. The gauge exposes only glass and silica to the gas, may be baked to 450°C, and gives an accuracy of pressure measurement of better than 5%.

533.5 : 531.788.5

1161. ON A PHOTOELECTRICALLY CONTROLLED RECORDING VACUUM GAUGE. E.Ulusoy.
Rev. Fac. Sci. Univ. Instanbul C, Vol. 22, No. 3, 232-3 (July, 1957). In German.

An instrument involving a mercury manometer with an inclined limb, a selenium photocell and recording apparatus is described for measurements in the range from 0.1 to 25 mm Hg.

R.Stratton

533.6.01

1162. SIMILITUDE IN AEROTHERMODYNAMICS OF VERY RAREFIED GASES. M.Devienne.
C.R. Acad. Sci. (Paris), Vol. 247, No. 12, 861-2 (Sept. 22, 1958). In French.

It is pointed out that it may not be legitimate to neglect the influence of the accommodation coefficient in using Knudsen's number to transfer from high to low pressures. S.Weintroub

533.6.01 : 533.7

1163. KINETIC THEORY OF GASEOUS FLOW THROUGH CYLINDRICAL TUBES. O.German.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1470-4 (1958). In Russian.

By introducing an "anisotropy function" good explanation of gaseous flow may be given even at pressures for which so far only empirical formulae have been used. The slip term is obtained automatically without any supplementary hypotheses, as well as the minimum flow rate at intermediate pressures. The final formula is qualitatively correct at all pressures, the intermediate pressures included.

533.6.011.311

1164. BOUNDARY LAYER IN A PERFECT GAS OVER A FLAT PLATE UNDER PRESSURE GRADIENT. M.Ray.
Bull. Calcutta Math. Soc., Vol. 49, No. 3, 133-8 (Sept., 1957).

533.6.011.4

1165. SHOCK-BOUNDARY LAYER INTERACTION ON A BODY AT MACH NUMBERS UP TO 5.
M.Z.v.Krzywoblocki and H.L.Roth.
Pakistan J. Sci., Vol. 10, No. 4, 181-91 (July, 1958).

The present review limits itself to the study of flow over a body. The emphasis is on the flow regime up to M = 5, thus limiting it to a continuum treatment. The references are grouped under five headings: transonic; supersonic; fully supersonic; limitations of various methods of solutions; general reviews and particular approaches.

## MOLECULAR THEORY OF GASES

533.7

1166. SOME RIGOROUS RESULTS FOR A MODEL IMPERFECT GAS. G.A.Baker,Jr.
Amer. J. Phys., Vol. 27, No. 1, 29-33 (Jan., 1959).

Shows that the classical similarity relations and virial theorem imply particular forms for the internal energy and the equation of state in systems where the potentials are homogeneous of degree n. It is also shown that for these systems the laws of mechanics imply that the differential of entropy is exact. Some results are rigorously deduced which must hold for any gas whose constituent particles interact by means of a homogeneous potential. One physical situation in which this model may be expected to be valid is the case of a totally ionized gas with a superimposed radiation field.

533.7

1167. RADIAL DISTRIBUTION FUNCTIONS IN BINARY GAS MIXTURES. E.L.Rubin and B.R.Sundheim.
J. chem. Phys., Vol. 29, No. 2, 278-81 (Aug., 1958).

The equations of Born and Green are generalized to the two component case. An approximate solution is formally obtained by a linearization procedure and is found to contain a singularity which is tentatively identified with the gas–liquid branch point of the radial distribution function. Temperature–density relations are found in the critical region by roughly locating this singular point. The results lend weight to the hypothesis that the singularity corresponds to the branch point.

533.7

1168. PROPERTIES OF GASES AT EXTREMELY HIGH TEMPERATURES. I.Amdur and E.A.Mason.
Phys. of Fluids, Vol. 1, No. 5, 370-83 (Sept.-Oct., 1958).

Known intermolecular force laws are used to calculate virial coefficients of the equation of state and the transport properties at very high temperatures for the rare gases and for molecular nitrogen. The crucial force laws which enable the calculations to be carried to high temperatures are those derived from molecular beam scattering measurements, which are valid at close distances of molecular approach. The calculations cover the temperature range from 1000° to 15000°K, but take into account only the translational degrees of freedom and neglect the effects of excitation, dissociation, and ionization. The treatment of mixtures is outlined, and illustrated by calculations for the binary system helium–argon. The methods which are used offer an approach to the problem of obtaining reasonably accurate estimates of gas properties at temperatures so high that direct experiments would be extremely difficult, if not impossible.

533.7

1169. THE BOLTZMANN EQUATIONS FOR GASES WITH ROTATING MOLECULES. L.Waldmann.
Z. Naturforsch., Vol. 12a, No. 8, 660-2 (1957). In German.

Suitable Boltzmann equations are obtained for gases whose molecules have rotational energy levels and where the Lorentz model of "one particle" scattering is assumed. Even when there is no detailed balancing a formally simple collision term appears. R.O.Davies

533.7 : 530.162

BASIS OF KINETIC THEORY AND THE BOLTZMANN EQUATION. See Abstr. 1102-3

533.72

1170. THE BOLTZMANN–MAXWELL EQUATION AS THE FUNDAMENTAL EQUATION OF GASDYNAMICS. T.Koga.
Mem. Fac. Engng Nagoya Univ., Vol. 9, No. 2, 268-73 (Nov., 1957).

A discussion of possible ways of finding solutions of the Boltzmann–Maxwell equation when the departure of a gas from thermal equilibrium cannot be ignored, with particular reference to slip flow near a solid wall. J.G.Oldroyd

533.72

1171. THE BOLTZMANN EQUATION FOR GASES CONSISTING OF PARTICLES WITH SPIN. L.Waldmann.
Z. Naturforsch., Vol. 13a, No. 8, 609-20 (Aug., 1958). In German.

Using the density matrix, the general expression for the rate of change (due to collisions) of the expectation value of any operator is derived, and a generalized Boltzmann integral equation is obtained for a gas consisting of particles with a given magnitude of spin. W.A.Hepner

533.72 : 536.23

1172. THE STRESS TENSOR, DIFFUSION AND HEAT FLOW IN DENSE INHOMOGENEOUS GASES. H.G.Reik.
Z. Naturforsch., Vol. 12a, No. 8, 663-5 (1957). In German.

Chapman and Cowling (Abstr. 7512/1953) and later Kohler (Abstr. 6310/1950) have shown that the second approximation is obtained for the heat flux and the stress tensor for a single component gas by suitably averaging over the present Enskog integral equation, which determines the error function to a second approximation. By this means the solving of this integral equation is avoided. The application to two or more component gases is demonstrated. H.C.Cole

## VIBRATIONS. ACOUSTICS

534.112

1173. ACOUSTIC BEHAVIOR OF A RUBBER STRING.
I.M.Freeman.
Amer. J. Phys., Vol. 26, No. 6, 369-71 (Sept., 1958).

The fundamental transverse vibration frequency of a rubber string remains almost constant when the string is stretched to greater lengths, in sharp contrast with the behaviour of a nearly inextensible string. Using the known elastic properties of rubber, the results of the analysis are found to agree quantitatively with experiment.

534.13

1174. METHOD FOR ANALYZING VIBRATION AT A SURFACE POINT. J.S.Arnold and J.G.Martner.
Rev. sci. Instrum., Vol. 29, No. 9, 779-83 (Sept., 1958).

The closed path (trajectory) traversed by a point on a vibrating surface is described in terms of two components normal to each other and contained in a plane perpendicular to the surface. For the analysis of this motion a biaxial vibration pick-up (BVP), using acceleration-responsive piezoelectric transducers, was developed. The signals for the BVP are combined by an X-Y oscilloscope to synthesize the amplified trajectory of the surface point to which the pick-up is applied. Phase and amplitude of the component signals are measured with a double-beam oscilloscope so that a motion map of the vibrating surface can be made.

534.131

1175. MINIMIZING DAMAGE FROM RANDOM VIBRATION. R.M.Mains.
J. Acoust. Soc. Amer., Vol. 30, No. 12, 1127-9 (Dec., 1958).

Damage is defined and examples are cited. Illustrative problems of relay contact arm chatter, gyro precession and noise generation, and stress fatigue in a structure are given. It is concluded that there are three means by which damage can be reduced: raising the damage threshold of the item, modifying the transmissibility of the intervening structure, or reducing the severity of the excitation. The examples are an attempt to show specifically how this can be done in practical cases.

534.131

1176. CONTOUR VIBRATIONS OF THIN RECTANGULAR PLATES. M.Onoe.
J. Acoust. Soc. Amer., Vol. 30, No. 12, 1159-62 (Dec., 1958).

An approximate theory based on an energy principle was applied for contour vibrations of rectangular plates and compared with experimental data of ADP Z-45° cuts with a satisfactory agreement. The existence of a special mode, which has attracted little attention heretofore, is shown and its connection with the complex branches of the dispersion equation is discussed.

534.133

1177. EXCITATION OF VERY-HIGH-FREQUENCY SOUND IN QUARTZ. H.E.Bömmel and K.Dransfeld.
Phys. Rev. Letters, Vol. 1, No. 7, 234-6 (Oct. 1, 1958).

Four experiments are reported on the generation and detection of sound waves ($10^9$ to $2.5 \times 10^9$ c/s) in quartz crystals which are placed with one end in the electric field of a coaxial cavity. These experiments confirm that the piezoelectric effect is a surface phenomenon, and that with a transmitter–receiver system the ratio of the electric power in to that out approximately verifies the calculated value. H.D.Parbrook

534.2 : 550.341

1178. THE VELOCITY OF RAYLEIGH WAVES ALONG A PRESTRESSED SEMI-INFINITE MEDIUM ASSUMING A TWO-DIMENSIONAL ANISOTROPY. F.Buckens.
Ann. Geofis., Vol. 11, No. 2, 99-112 (April, 1958).

The velocity equation is deduced for the Rayleigh waves in an idealized medium of uniform two-dimensional anisotropy and the propagation of the waves is discussed, with special reference to cases where there is an initial stress acting in the direction of propagation. Five instead of four independent elastic constants are necessary. The special types of anisotropy considered appear in different geological formations and although the effect of the initial stress is usually very small on the Rayleigh wave velocity, it may be considerable on the elastic constants. Application of the results to geophysical problems is difficult because of the lack of data on the elastic constants of anisotropic geological formations.

H.J.H.Starks

534.2

1179. ON THE INTERPRETATION OF HUYGENS' PRINCIPLE: ACOUSTIC, ELASTIC, AND ELECTROMAGNETIC WAVES. II. P.Boillet.
Cahier de Phys., Vol. 11, 238-68 (June, 1957). In French.

A continuation of Abstr. 543 (1958). The analogue of Huygens' principle in the case of elastic waves is established by general mathematical analysis. J.G.Oldroyd

534.2

1180. PROPAGATION IN AN INFINITE ELASTIC PLATE. J.W.C.Sherwood.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 979-84 (Oct., 1958).

At any single frequency an arbitrary force distribution of an infinite elastic plate must be expressible as a superposition of the plate's eigenvibrations. Since the force distribution may be varied in an infinite number of ways it follows that the plate must possess an infinity of eigenvibrations. Previous work has shown the existence of only a finite number, each being defined by a real propagation constant (unattenuated vibration: infinite phase velocity). This investigation yields the complementary infinity of eigenvibrations possessing complex propagation constants (exponentially attenuated vibrations: finite phase velocities). The probable structure of the complete eigenmode system in the low-frequency range was hypothesized for a plate material with a Poisson's ratio of 0.31. The qualitative variation of this structure with changes in Poisson's ratio may be readily conjectured. The utility of the complex eigenvibrations is enhanced by transforming them into an equivalent set, each member of which is constant in phase throughout the plate. These reformulated eigenvibrations are unique in that they possess an exponential amplitude variation along the plate together with a superimposed sinusoidal variation.

534.2

1181. PAPERS PRESENTED AT THE CONFERENCE ON ELASTIC WAVE PROPAGATION, CALIFORNIA INSTITUTE OF TECHNOLOGY, MARCH 7 AND 8,1957. Edited by T.W.Spencer.
J. geophys. Res., Vol. 63, No. 3, 577-649 (Sept., 1958).

A report of an informal conference. The contributions are grouped in three sections: I. Earthquake seismology; II. Propagation in non-homogeneous media; III. Propagation in homogeneous media.

534.2

1182. THE GENERATION OF SECONDARY SIGNALS IN THE PROPAGATION OF ULTRASONIC WAVES IN BOUNDED SOLIDS. M.Redwood.
Proc. Phys. Soc., Vol. 72, Pt 5, 841-53 (Nov., 1958).

In the propagation of short-duration trains of compressional waves in bounded solid media, secondary wave-trains are generated as a result of the partial conversion of compressional waves to transverse waves at the boundaries of the media. The phase relation between these secondary signals and the main compressional signal is analysed here, with reference to the propagation of waves of frequency of the order of 10 Mc/s in solid cylindrical specimens. The theoretical analysis is compared with experimental results The results are of importance in applications of the ultrasonic pulse technique to the accurate measurement of the velocity and absorption in solids, and also help to clarify certain characteristics of the propagation of continuous waves in bounded media.

534.21

1183. MEASUREMENTS OF FINITE AMPLITUDE DISTORTION OF PROGRESSIVE ULTRASONIC WAVES AT MODERATE INTENSITIES. K.L.Zankel and E.A.Hiedemann.
Naturwissenschaften, Vol. 45, No. 14, 329-30 (1958).

These were determined for waves in water and carbon tetrachloride by measuring the absorption of the harmonics using diffraction techniques, and applying the theory of Thuras et al.(Abstr. 516/1935). H.D.Parbrook

534.213 : 541.135

1184. EFFECT OF PRESSURE ON ULTRASONIC RELAXATION IN ELECTROLYTES. E.H.Carnevale and T.A.Litovitz.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 610-13 (July, 1958).

Measurements of the ultrasonic absorption and velocity were made on aqueous solutions of ammonia up to pressures of 2030 kg/cm². The results show that the absorption decreases and the relaxation frequency increases as the pressure is raised. The data are consistent with the assumptions of Eigen that the excess sound absorption is due to a chemical relaxation effect brought about by the lag in the shift in the equilibrium $NH_3 \cdot H_2O \rightleftharpoons NH_4^+ + OH^-$, and that the rate of the reaction is diffusion controlled.

534.213

1185. INVESTIGATION OF PROGRESSIVE ULTRASONIC WAVES BY LIGHT REFRACTION. M.A.Breazeale and E.A.Hiedemann.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 751-6 (Aug., 1958).

The optical method used by Loeber and Hiedemann (Abstr. 1929/1956) for the study of stationary ultrasonic waves was adapted to the study of progressive waves. Three methods are described by which one may determine the presence of distorted wave-forms in liquids. Distorted wave-forms caused by finite amplitude effects are shown to be present in liquids and the increase of wave-form distortion with distance is shown for water and carbon tetrachloride.

534.213 : 535.551

1186. VISUALIZATION OF MODE CONVERSION OF AN ULTRASONIC BEAM IN FUSED QUARTZ. V.J.Hammond and R.Carter.
Nature (London), Vol. 182, 790 (Sept. 20, 1958).

The method of Johnson (1953) was applied, namely (a) a schlieren system to make visible the periodic density variations in the fused quartz, and (b) crossed "Polaroids" on each side of the quartz to delineate the regions of birefringence caused by the high ultrasonic strain. H.D.Parbrook

534.213

1187. THE PROPAGATION OF ULTRASONICS IN SUSPENSIONS OF LIQUID GLOBULES IN ANOTHER LIQUID. P.A.Allinson and E.G.Richardson.
Proc. Phys. Soc., Vol. 72, Pt 5, 833-40 (Nov., 1958).

In continuation of earlier work (Abstr. 2739/1956) measurements were made of the attenuation of ultrasonics in a liquid containing globules of another liquid in suspension, i.e. in an emulsion. The effect of the viscosity of the continuous liquid and

of the mean size of the globules of the other liquid on the attenuation is investigated and tested against a theoretical formula. It is shown that besides viscous loss relevant factors are (a) scattering of the radiation out of the direct beam, (b) pulsation of the globules.

534.22 : 518.5

1188. ELECTRICAL ANALOGUES OF ACOUSTIC RELAXATION PHENOMENA. K.Walther.
Acustica, Vol. 6, No. 2, 245-51 (1956). In German.

The possibilities are considered of measuring directly relaxation time and characteristics from the distortion of an acoustic rectangular pulse. Because of the necessary wide bandwidth it is not possible to realise these considerations experimentally with the electroacoustic transducers available. The acoustic phenomena are translated into electrical analogues. The problem of the separation of two relaxation times is investigated using a two-terminal network.

534.22

1189. INFLUENCE OF THE THICKNESS OF THE WALLS OF A RESONANCE TUBE ON THE SPEED OF SOUND IN LIQUIDS. C.Sălceanu and M.Zăgănescu.
C.R. Acad. Sci. (Paris), Vol. 247, No. 11, 812-14 (Sept. 15, 1958). In French.

Theoretical expressions are developed for the case where the wavelengths of the radial wave in the tube wall is much greater than the radii of the internal or external walls. H.D.Parbrook

534.22

1190. A METHOD FOR ESTIMATING THE ULTRASONIC VELOCITY IN SOLIDS. K.C.Lal.
Curr. Sci., Vol. 27, No. 10, 387 (Oct., 1958).

Letter reporting that the empirical formulae due to Rao relating velocities, molecular weights and densities in liquid mixtures can be extended to include the case of a solid solute (benzoic acid) in solvents, and suggesting that an estimate of the velocity in a pure solid can be made. H.D.Parbrook

534.22 : 534.23

1191. ATTENUATION AND DISPERSION OF SOUND BY SOLID PARTICLES SUSPENDED IN A GAS. J.W.Zink and L.P.Delsasso.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 765-71 (Aug., 1958).

Observations were made on audio-frequency sounds propagating through a gaseous medium containing small solid particles in suspension. Two effects were observed, the attenuation and the dispersion. The measurements were carried out by sending short trains of sine waves through the particle-filled gas and observing the changes in the transmitted train of waves after the particles settled out of the gas. The variation in arrival time of the pulse was used to determine the velocity change caused by the suspended particles. Changes in the amplitude of the received pulse made it possible to determine the additional attenuation due to the suspended particles. The variations of the attenuation and velocity with frequency due to the particle-filled gas were obtained and the results compared with theory. The measured attenuation was found in good agreement with existing theory. The observed dispersion is satisfactorily accounted for by a theory that is introduced in this paper. The attenuation theory takes into account enhanced viscous and thermal losses caused by the suspended particles. The dispersion theory predicts the velocity shift resulting from changes of the heat capacity and density of the gas containing the suspended particles.

534.22 : 536.48

1192. VELOCITY OF SOUND IN LIQUID HELIUM. A.van Itterbeek.
Nuovo Cimento Suppl., Vol. 9, No. 1, 291-6 (1958).

The velocity of sound (w) was measured by means of an interferometric method at temperatures of 1.1 and 0.985 °K, and at frequencies of 219-1485 kc/s. Results fit well the w—temperature curve as established by previous authors. No dispersion is observed, in spite of the fact that the absorption—temperature curve has a maximum at 0.9 °K. Further measurements were made at audible frequencies with gaseous helium; w was measured between 1.8 and 4.3 °K. The λ-point does not show any anomaly in the w—temperature curve of the gas. R.Eisenschitz

534.22 : 536.48

1193. VELOCITY OF SOUND IN A $^3$He—$^4$He MIXTURE. E.W.Guptill, A.C.H.Hallett and C.C.Lim.
Nuovo Cimento Suppl., Vol. 9, No. 1, 341 (1958).

Cylindrical $BaTiO_3$ transducers were used to measure the velocity of sound in solid argon and in a 4% $He^3$—$He^4$ mixture. In the case of solid argon, high attenuation resulted in rather poor accuracy (about 2%). The $He^3$—$He^4$ measurements have an accuracy of 0.1% and show that the λ point for the mixture shifts towards lower temperature. Preliminary results indicate that the presence of $He^3$ lowers the attenuation in the region of the λ point and increases the attenuation above 2.3°K.

534.222.2 : 536.46

1194. RELAXATIONAL INTERACTION OF SHOCK WAVES WITH A COMBUSTION ZONE. S.M.Kogarko and V.I.Skobelkin.
Dokl. Akad. Nauk SSSR, Vol. 120, No. 6, 1280-3 (1958). In Russian.

A mathematical study shows that the experimentally observed intensification of shock waves in passing through the combustion zones of some explosive mixtures can be explained by a conversion of the chemical energy of the combustion into mechanical energy of the shock wave, which reaches a maximum when the time of residence of the shock wave in the combustion zone is equal to or greater than the reaction time, defined as the ratio of the width of combustion zone to normal flame propagation rate. R.C.Murray

534.222.2

1195. RADIO OBSERVATIONS OF HYPERSONIC SHOCK WAVES. J.S.Hey, J.T.Pinson and P.G.Smith.
Nature (London), Vol. 182, 1220-1 (Nov. 1, 1958).

Measurements of the velocity of shocks through air by the Doppler shift (see Abstr. 9573/1957) show that, with a combustible $H_2$—$O_2$ driver, there is strong attenuation, the Mach number falling from 14 to 7 in 10 m. A double diaphragm system, using cold hydrogen as driver, an intermediate section filled with argon, and then air, is a better method for producing strong shocks and gives negligible attenuation of shocks around Mach 12 over a distance of 5 m. A.G.Gaydon

534.222.2 : 778.37

1196. CYLINDRICAL SHOCK WAVES FROM EXPLODING WIRES. F.D.Bennett.
Phys. of Fluids, Vol. 1, No. 4, 347-52 (July-Aug., 1958).

A simple technique was found for rendering visible the shock wave formed by an exploding wire after the shock has separated from the luminous contact surface. A small, plane mirror is placed just behind the wire so as to be perpendicular to the axis of the optical system. Thus the reflected image of the wire explosion coincides with the disturbance itself when seen through the slit by the camera lens. Rotating mirror pictures taken under these conditions show very clear outlines of the parabolic shock wave as it propagates ahead of the luminous contact surface. The separation of the shock and contact surface is complete by about 1 μsec. Beyond this time the shock is clearly non-luminous and ordinarily would not be visible. Comparison of shock trajectories with predictions from the similarity solutions for strong shock-waves obtained by Lin may be interpreted as showing that the shock is receiving additional energy while traversing the early part of its path. After this phase both shock and contact surface accurately obey a parabolic law over intervals of several microseconds.

534.222.2 : 536.75

1197. ENTROPY CHANGE DURING RELAXATION OF A GAS BEHIND A SHOCK WAVE. Yu.P.Lun'kin.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1526-30 (1958). In Russian.

The changes in entropy in shock waves which take place as translational, rotational and vibrational degrees of freedom are successively excited and dissociation is induced were investigated. It is shown that the largest change in entropy occurs when the translational degrees of freedom are excited. Excitation of other degrees of freedon involves smaller entropy variations.

534.222.2 : 536.2.083

CALORIMETER HEAT TRANSFER GAUGE FOR USE IN SHOCK TUBES. See Abstr. 244

534.222.2 : 539.211

FRACTURES PRODUCED BY STRESS PULSES IN GLASS-LIKE SOLIDS. See Abstr. 833

534.23 : 538.56 : 535.13 : 530.19

TOROIDAL WAVE FUNCTIONS. See Abstr. 1112

534.23

1198. THE ABSORPTION OF SOUND IN AIR AT AUDIO FREQUENCIES. E.J.Evans and E.N.Bazley.
Acustica, Vol. 6, No. 2, 238-45 (1956).

A determination is described of the sound absorbing properties of air at frequencies from 1 to 12.5 kc/s, for values of the relative humidity from about 5% to 85% at 20°C. The measurements were

made in a large reverberation chamber, in which the surface absorption was very small. The absorption due to the air was evaluated by an analysis of the results of measurements of the empty chamber absorption. The data obtained represent a revision of previously published results and are in close agreement with the relaxation theory. A general expression is derived for the attenuation of sound in air as a function of the frequency, humidity and temperature.

534.23

1199. SOUND ABSORPTION IN AIR IN ROOMS. R.W.Young.
J. Acoust. Soc. Amer., Vol. 29, No. 2, 311 (Feb., 1957).

A table is given, based on the results of Evans and Bazley (see preceding abstract), which enables air absorption to be determined at different frequencies and relative humidities. G.F.Hodsman

534.23

1200. ULTRASONIC ABSORPTION MEASUREMENTS IN $MgSO_4$, $ZnSO_4$, $CoSO_4$ AND $NiSO_4$ AT 3 Mc/s. S.K.Kor.
Curr. Sci., Vol. 27, No. 9, 339-40 (Sept., 1958).

534.23

1201. THE ABSORPTION OF SOUND IN SEDIMENTS.
J.Busby and E.G.Richardson.
Geophysics, Vol. 22, No. 4, 821-8 (Oct., 1957).

Measurements were made of the attenuation of sound in compacted sediments in water using an ultrasonic wave train at frequencies in the megacycle range. Artifical sediments of glass spheres as well as marine sands were tested. The variation of absorption with frequency, mean grain size, and concentration are illustrated.

534.23

1202. SOUND ABSORPTION IN HYDROGEN.
H.D.Parbrook and W.Tempest.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 985-6 (Oct., 1958).

Improved absorption results in hydrogen in the frequency–pressure range from 0.45 to 44 Mc/s atm are reported and their theoretical implications briefly reviewed. H.D.Parbrook

534.23 : 537.312.62

1203. ULTRASOUND ATTENUATION IN METALS AT LOW TEMPERATURES IN THE NORMAL AND SUPERCONDUCTING STATE. G.Kurtze.
Naturwissenschaften, Vol. 44, No. 13, 368-70 (1957). In German.

Review of a paper by W.P.Mason and H.E.Bömmel (Abstr. 181/1957). H.London

534.23

1204. ULTRASONIC ABSORPTION AND VELOCITY IN TRIETHYLAMINE. G.Busch and W.Maier.
Z. Naturforsch., Vol. 11a, No. 9, 765-6 (1956). In German.

The shear wave makes only an insignificantly small contribution to the absorption measured at frequencies of 1.34 and 4.17 Mc/s, and at temperatures between $-55^\circ$C and $+35^\circ$C. The energy appears to be used up by a relaxation process with a frequency of about 4 Mc/s at $-45^\circ$C, for example. The absorption in diethylamine is of a much smaller order of magnitude, and there is no evidence of an $\alpha/\nu^2$ maximum. R.Schnurmann

534.23

1205. STUDIES IN ULTRASONIC PROPAGATION IN MIXTURES OF ETHYL ALCOHOL AND WATER.
S.Parthasarathy and M.Pancholy.
Z. angew. Phys., Vol. 10, No. 10, 453-5 (Oct., 1958).

Measurements of the absorption and velocity at 21 Mc/s, and from $10^\circ$ to $50^\circ$C, are reported. The absorption peaks at about 30% mol. concentration of alcohol may result from molecular association. H.D.Parbrook

534.23 : 539.32

ATTENUATION OF SOUND AT 5 Mc/s IN HIGH PURITY ALUMINIUM. See Abstr. 874

534.231

1206. THEORETICAL STUDY OF AN ULTRASOUND FIELD.
N.Segard and J.Cassette.
C.R. Acad. Sci. (Paris), Vol. 247, No. 11, 809-12 (Sept. 15, 1958). In French.

Expressions are developed for the sound pressure at a point in an ultrasound field in a liquid at a given time. The solution differs from that proposed by Seki et al. (Abstr. 3579/1956). H.D.Parbrook

534.232

1207. THE THERMOPHONE — AERODYNAMIC PISTONPHONE.
P.Riety.
Acustica, Vol. 6, No. 2, 251-8 (1956). In French.

A theory of the thermophone is presented based on the application of general thermodynamic principles. The acoustic pressure inside the thermophone is calculated and found to agree with an earlier formula of the author's derived by more rigorous theory. The new formula should give results in accordance with those of the methods commonly used for calibrating microphones.

534.232

1208. STUDIES ON THE NEAR FIELDS OF MONOPOLE AND DIPOLE ACOUSTIC SOURCES. C.W.Horton and A.E.Sobey, Jr.
J. Acoust. Soc. Amer., Vol. 30, No. 12, 1088-99 (Dec., 1958).

It is shown that when an observer is not farther than one wavelength from an acoustic source, he can determine the distance to the source from measurements of the pressure and of the particle velocity of the medium. The expressions are developed using integrals of the power so that they are relatively insensitive to the pulse shape. Exact expressions are obtainable only in the case of a monopole source. However, a ratio $R_2$ is introduced which shows a monotonic dependence on distance in the near field and which is surprisingly insensitive to the nature of the source and to the shape of the wave. Experimental measurements are carried out for a dipole source. Agreement between the theory and the experiment is only moderate because of the difficulty in making sufficiently accurate acoustic measurement.

534.232

1209. ON THE DYNAMICS OF A BULL WHIP.
B.Bernstein, D.A.Hall and H.M.Trent.
J. Acoust. Soc. Amer., Vol. 30, No. 12, 1112-15 (Dec., 1958).

The production of a cracking sound by a bull whip is discussed. Photographic evidence shows that the crack is produced by the tip of the whip exceeding the speed of sound and giving off shock waves rather than by the whip slapping itself. This evidence includes motion pictures as well as still shadow pictures which show the tip shedding shock waves. There follows a mathematical discussion of an idealized bull whip with a view to the problem of how the free end of this mechanism achieves a high velocity while the end held in the hand moves relatively slowly. A mathematical solution is given in which it is assumed that a discontinuity in tension propagates down the whip.

534.232: 539.32

ELASTIC LOSSES IN SYNTHETIC QUARTZ RESONATORS. See Abstr. 871

534.24

1210. REFLECTIONS FROM GRADUAL TRANSITION SOUND ABSORBERS. N.B.Miller.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 967-73 (Oct., 1958).

Reflections from gradual transition linings for anechoic tanks are treated theoretically by considering the propagation of compressional waves in stratified media. The reflections are the combined effect of back-scattering in the transition region and round trip transmission through the lining resulting from imperfect absorption of sound by the lining. Sound propagation in the inhomogeneous transition region is fairly complex; the incident energy is absorbed and scattered back and forth, and phase interference occurs in a complicated fashion. If the lining is viewed as a succession of arbitrarily thin panels, however, then the pressure is readily separated into progressive waves, and it is shown that each increment of distance "back-scatters" a fraction of the total incident wave that is proportional to the logarithmic derivative of the characteristic impedance. Certain typical types of linings are considered in detail to determine theoretically the proportions of transition width to total lining width producing minimum reflections. The theoretical results are compared with experimental data for a cone type underwater lining, showing that the one-dimensional theory gives useful results for cone and wedge linings.

534.24

1211. REFLECTION FROM A FLUID OF HIGHER SOUND VELOCITY. J.C.Savage.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 974-8 (Oct., 1958).

The method of Cagniard is employed to obtain an exact solution for the pressure response to a spherically symmetric acoustic pulse originating at a source within a semi-infinite fluid bounded below by a fluid of higher sound velocity. The solution is expressed in terms of elliptic integrals. The shape of that portion of the response known as the refracted arrival is shown to depend principally upon the

density contrast. The response is plotted as a function of time for parameters which represent the reflection process from the ocean bottom. If the pulse from the source has a steep initial rise time, then reflection at angles greater than the critical angle may lead to unexpectedly large amplitudes for a brief time interval. It is suggested that this phenomenon may introduce nonlinear effects into the reflection process.

534.26 : 534.321.9

1212. DIFFRACTION EFFECTS IN THE ULTRASONIC FIELD OF A PISTON SOURCE. R.Bass.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 602-5 (July, 1958).

Diffraction effects in the ultrasonic field of a circular piston source are discussed with particular reference to the measurement of ultrasonic absorption in liquids by the pulse technique at frequencies of 1 Mc/s and above. A relationship given by Williams (Abstr. 4198/1951) for the acoustic pressure, integrated over a "measurement circle" equal in area and coaxial with the source, is used to develop a new formula representing the apparent attenuation due to diffraction. This is simpler and more general than the corresponding formula derived by Williams. It covers all distances between source and detector larger than the radius of the source irrespective of the ultrasonic wavelength in the medium. Measurements made in water at frequencies of 1 and 3 Mc/s confirm the theory qualitatively.

534.3

1213. OBSERVATIONS ON THE ACOUSTICAL CHARACTERISTICS OF THE ENGLISH FLUTE. R.Herman.
Amer. J. Phys., Vol. 27, No. 1, 22-9 (Jan., 1959).

A discussive presentation is given of the English flute, or recorder as a serious musical instrument including remarks based on acoustical theory and experiment, concerning such matters as intonation, partial content, blowing pressure, and some possible criteria for the "good" recorder, among other subjects.

534.321.9

1214. TWO NEW SMALL ULTRASONIC VESSELS FOR THE LABORATORY. R.Dallendörfer.
Exper. Tech. der Phys., Vol. 2, No. 1, 17-22 (Jan., 1954). In German.

Details are given of the design and performance of two pieces of equipment for the direct excitation of samples of about 20 ml of liquid. H.J.H.Starks

534.372 : 532.623

1215. EXPERIMENTAL DETERMINATION OF THE DAMPING OF PULSATING AIR BUBBLES IN WATER IN THE FREQUENCY RANGE 100 TO 300 kc/s. H.Haeske.
Acustica, Vol. 6, No. 2, 266-75 (1956).

See Abstr. 186/1957.

534.512.1 : 535.42

THE "METHOD OF PARTS" FOR THE DIFFRACTION OF LIGHT BY SUPERPOSED AND STANDING SUPERSONIC WAVES. See Abstr. 229

534.61 : 534.321.9

1216. PIEZOELECTRIC PROBE OF QUARTZ CONSTRUCTED TO MEASURE ULTRASOUND PRESSURE AND TO STUDY AN ULTRASOUND FIELD. N.Segard, J.Cassette and F.Cocquerez.
C.R. Acad. Sci. (Paris), Vol. 247, No. 12, 873-6 (Sept. 22, 1958). In French.

Some details are given of its construction and performance. H.D.Parbrook

534.7

PHYSIOLOGICAL ACOUSTICS. HEARING. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

534.782

1217. SEGMENTATION TECHNIQUES IN SPEECH SYNTHESIS.
G.E.Peterson, W.S.-Y.Wang and E.Sivertsen.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 739-42 (Aug., 1958).

A basic method of speech synthesis is described in which discrete segments of recorded utterances are joined together to produce continuous speech. The segments are characterized as (a) containing parts of two phones with their mutual influence in the middle of the segment, and (b) beginning and ending at the phonetically most stable position of each phone. All segments containing the same articulatory sequence were defined as a dyad. The method of synthesis described includes not only articulatory phones, but also intonation, stress, and duration. A large number of segments is required and various techniques of obtaining the segments for speech synthesis are discussed. The method is limited to a specific dialect, and practically it is limited to a single speaker. See also following abstract.

534.782

1218. SEGMENT INVENTORY FOR SPEECH SYNTHESIS.
W.S.-Y.Wang and G.E.Peterson.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 743-6 (Aug., 1958).

See preceding abstract. The inventory of segments required to synthesize an idiolect of American speech from recorded utterances was partially investigated. A total of 43 phonetic units, including a unit of silence, is found essential. These units represent some of the major allophones of the phonemes of the idiolect. To obtain the segments, utterances are constructed with the desired sequence of the two phonetic units and with the proper intonation and stress environment. The utterances are recorded on magnetic tape, and the desired boundaries of the segments are determined by means of a technique employing a sound spectrograph. An attempt is made to match harmonics, formants, and amplitude envelopes between adjacent segments. To synthesize the idiolect it is estimated that an inventory of about 8500 segments is required. A sentence synthesized from over 40 such segments is demonstrated.

534.833

1219. JET NOISE REDUCTION BY INDUCED FLOW.
I.Dyer, P.A.Franken and P.J.Westervelt.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 761-4 (Aug., 1958).

The effect on the generation of jet noise by the secondary air induction of a modified jet nozzle is analysed. It is shown that the combination of the secondary air with the primary jet air creates a new jet stream of larger area, lower velocity, and lower noise generation. The decrease in noise radiation is found in terms of the area of the combined jet stream. Detailed check of the theory is not possible at present because measurements of the areas of the combined jet streams have not been generally made along with measurements of the noise. However, it is possible to estimate the upper limit of the appropriate jet stream area in order to obtain the upper limit on noise reduction. The upper limit on noise reduction obtained from the theory is consistent with existing measurements. Qualitative conclusions from the theory with respect to the spectrum and directivity of the noise radiated by jets with modified nozzles are in accord with measurements.

534.837

1220. NOISE ORIGIN, POWER, AND SPECTRA OF DUCTED CENTRIFUGAL FANS. F.S.Howes and R.R.Real.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 714-20 (Aug., 1958).

Forward and backward curved blade centrifugal fans as noise sources were subjected to an extensive study, measurements being made in a duct with an acoustic termination. The data obtained support the following conclusions: (1) The noise output from each homologous series of fans can be defined by one V-shaped specific noise power v. log specific speed curve, with minimum close to maximum static efficiency. (2) Fan outlet noise power at maximum fan efficiency approximates $10^{-5}$ times the input fan power. (3) The noise origin is primarily blade and air flow boundary turbulence.

534.839

1221. PORTABLE INSTRUMENT FOR LOCATING NOISE SOURCES IN MECHANICAL EQUIPMENT.
D.A.Gilbrech and R.C.Binder.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 842-6 (Sept., 1958).

A portable direction finder utilizing correlation techniques was developed for locating noise sources in mechanical equipment. A description of this instrument and some test results are given. The test results include studies of the direction finding characteristics of the apparatus and a simple method of determining wave-fronts.

534.839

1222. NOISE MEASUREMENT TECHNIQUES.
Notes appl. Sci. Nat. Phys. Lab., No. 10, 40 pp. (1955).

534.84

1223. APPLICATIONS OF THE MONTE CARLO METHOD TO ARCHITECTURAL ACOUSTICS. II. J.C.Allred and A.Newhouse.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 903-4 (Oct., 1958).

For Pt I, see Abstr. 1580 (1958). Previous Monte Carlo studies of the statistical value of the mean free path and the frequency of collision of a geometric ray with the walls of a rectangular parallelepiped are revised and amplifier. A systematic increase in the ratio of the mean free path calculated from statistical studies to the mean free path taken as $4V/S$ is observed to occur as the parallelepiped deviates from a cubical to a long, narrow, or a wide, low shape. The ratio of statistical mean free path to $4V/S$ and the relative collision frequencies with various walls as compared with normalized wall areas are given in tabular form.

534.845

1224. THE FLOW RESISTANCE OF POROUS BUILDING MATERIALS. F.Barthel.
Acustica, Vol. 6, No. 2, 259-65 (1956). In German.

The static air-flow resistance and porosity of common building materials are measured. The flow resistance in some cases rises very steeply with air velocity, a result not found for the measured sound absorbing materials with fine pores. There is good agreement between the static flow resistance and acoustic resistance (deduced from measurements of wall impedances in a tube) for absorbent materials with fine pores, but in certain samples of brick the acoustic flow resistance is larger than the static flow resistance and increases beyond a sound pressure level of 100 dB with air velocity. Values of "structure factor" up to 10 are found for the brick samples.

534.845

1225. SOUND ABSORPTION COEFFICIENTS OF VERMICULITE MORTARS. C.G.Balachandran and T.V.S.Murty.
J. sci. industr. Res., Vol. 17B, No. 7, 286-7 (July, 1958).

These were measured, using the tube method, at six frequencies between 125 and 4000 c/s. H.D.Parbrook

534.845.1

1226. NEW AIRBORNE SOUND TRANSMISSION LOSS MEASURING FACILITY AT RIVERBANK. R.L.Richards.
J. Acoust. Soc. Amer., Vol. 30, No. 11, 999-1004 (Nov., 1958).

A new sound-transmission-loss measuring facility has been in use at Riverbank Acoustical Laboratories for more than a year now. This paper describes the two reverberation rooms, installation of the test panel, instrumentation, and measurement technique. The several checks made for measurement accuracy and repeatability are discussed. Test results are given comparing the old method of test with the new, and results are also given for a folding door measured at four testing laboratories in the United States and Canada.

534.88

1227. FLUCTUATION OF SOUND PULSES TRANSMITTED VERTICALLY IN THE SEA. J.N.Nanda and V.N.Rao.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 639-41 (July, 1958).

This paper discusses the advantages of studying fluctuations of underwater sound in vertical transmission and points out the drawbacks of the horizontal transmission studies. Certain experiments eliminating avoidable known causes of fluctuations were carried out at the Indian Naval Physical Laboratory and are described. The results show that the variation coefficient of fluctuation has a higher value than those reported by other workers in other areas. The suggestion put forward by Nanda that scattering by zooplankton may be responsible for this large fluctuation is supported.

# OPTICS. SPECTRA. LUMINESCENCE

535

1228. 59TH CONFERENCE OF THE GERMAN APPLIED OPTICS ASSOCIATION, HELD IN VIENNA, 27TH TO 30TH OF MAY, 1958.
Optik, Vol. 15, No. 10, 585-639 (Oct., 1958). In German.

Some 30 papers on miscellaneous optical subjects are mentioned, those on the following topics being reported in detail. Mass and energy relations in photons and other elementary particles; transmission of monochromators; ray-tracing; spectacle lens design; photoelectric focusing; test-objects; equidensitometry; transmission of optical glasses; spectral sensitivity of photocells; response function theory. W.T.Welford

535.13 : 534.23 : 538.56 : 530.19

TOROIDAL WAVE FUNCTIONS. See Abstr. 1112

535.135 : 538.566.2

1229. MAXWELL FISH-EYE TREATED BY MAXWELL EQUATIONS. Chen To Tai.
Nature (London), Vol. 182, 1600-1 (Dec. 6, 1958).

On substituting the radially varying refractive index in Maxwell's electromagnetic equations and making suitable changes of variables, the differential equations for the electric and magnetic field strengths are reduced to forms of the hypergeometric equation. The fish-eye is thus treated as a boundary-value problem. W.T.Welford

535.214 : 534.232

1230. OBSERVATION OF THE OPTICO-ACOUSTIC EFFECT IN LIQUIDS. E.F.Gross, Ya.Ya.Abolin'sh and A.A.Shultin.
Zh. tekh. Fiz., Vol. 28, No. 4, 832-5 (1958). In Russian.

The acoustic effects produced when liquids (water, methyl alcohol, ethyl alcohol) are exposed to intermittent illumination were studied. The amplitude of the acoustic signal obtained depends strongly upon the modulation frequency of the illuminating beam of light. Experiments are continuing on the observation of the same phenomenon in crystals.

535.222

1231. LABORATORY MEASUREMENT OF THE VELOCITY OF LIGHT. W.P.Alford and A.Gold.
Amer. J. Phys., Vol. 26, No. 7, 481-4 (Oct., 1958).

The method is based on the result that the Fourier transform of a pair of identical pulses yields a frequency spectrum with zeros which are simply related to the time separation of the pulses. The principal pieces of apparatus required for the experiment are a photomultiplier and high-voltage power supply, and a short-wave radio receiver. With this equipment and path lengths of 50-100 ft, c may be readily measured to an accuracy of 1% or better.

535.23

1232. ON RADIATION MODULATION. R.B.McQuistan.
J. Opt. Soc. Amer., Vol. 49, No. 1, 70-4 (Jan., 1959).

The distribution of modulation frequencies was determined for radiation chopped by passing chopper teeth, whose sides are radii of the chopper wheel, over a circular aperture. The calculation reported establishes the relationship between the aperture radius-to-chopper wheel radius ratio and the number of notch-tooth pairs that will produce an amplitude of the fundamental frequency equal to the amplitude obtained for the ideal sinusoidal modulation of the radiation emanating from the same aperture. The r.m.s. value of the radiation modulated in the assumed manner is also discussed.

535.23.08

1233. MEASUREMENT OF SPECTRAL EMISSIVITY FROM 2 $\mu$ TO 15 $\mu$. C.D.Reid and E.D.McAlister.
J. Opt. Soc. Amer., Vol. 49, No. 1, 78-82 (Jan., 1959).

An accessory designed and constructed for use with a double-beam spectrophotometer is described, which permits the measurement of spectral emissivities of opaque materials at room temperatures. The measurements made are of total (specular plus diffuse) spectral reflection. From this value the spectral emissivity is obtained by subtraction from one. The new source consists of a heated enclosure to supply the energy and a twin optical system to lead the respective sample and reference beams into the instrument. Part of this optical system is removable to permit normal operation of the spectrophotometer and replaceable without readjustment. A temperature-controlled water supply is used to cool the sample. A method for extending the use of this equipment to measure emissivities of low conductivities is outlined.

535.23.08 : 536.33.08

MODERN BOLOMETERS. REVIEW. See Abstr. 251

535.23.08 : 539.1.07

SEMICONDUCTOR P–N JUNCTION RADIATION COUNTER. See Abstr. 499

535.241.3 : 621.326.71

1234. THE AGEING OF VACUUM STANDARD LAMPS ON A.C. AND D.C. W.Barnett, R.G.Berry and J.S.Preston.
Brit. J. appl. Phys., Vol. 9, No. 8, 317-18 (Aug., 1958).

A comparison is made of the rates of fall of luminous intensity and current, at constant voltage and colour temperature 2390°K approximately, of 100 V 30 W vacuum photometric standard lamps, on a.c. and d.c. supplies. The rate for intensity is considerably higher on d.c. than on a.c., while the rate for current is lower. These specific effects of d.c. operation can be accounted for simply by changes in filament emissivity. The effects are shown to be almost fully reversible, after many hours of burning, by suitable application of reversed d.c., and a.c., supplies. As for gasfilled lamps, the usefully smaller rate of depreciation characteristic of a.c. operation may be fully retained on d.c. by reversal of polarity at regular convenient intervals, so that the use of a.c. becomes legitimate for the normal preliminary ageing tests.

535.3 : 538.561

INDUCED AND SPONTANEOUS EMISSION IN A COHERENT FIELD. See Abstr. 474

535.31

1235. THE USE OF MATRIX ALGEBRA IN GEOMETRICAL OPTICS. W.Brouwer.
University of Delft Dissertation (1957) 77 pp.

The transformation between object- and image-space coordinates of a ray is expressed in matrix form, including terms up to cubic in aperture and field. Aberration terms equivalent to Seidel

terms are derived. Applications are made to plane mirrors, Gaussian optics of centred and decentred systems and stop-shift effects on Seidel terms. W.T.Welford

535.31 : 537.533.3

1236. CHARACTERISTIC CURVES ON PLANES IN THE IMAGE SPACE. N.Chako.
Chalmers Tekn. Högsk. Handl., No. 191, 49 pp. (1957).

By a characteristic curve is meant the curve in which a bundle of rays from a single object point and a narrow ring in the pupil intersect a plane in the image space. They are shown to be epicycloids and their general forms in the Seidel region are derived as functions of the aberration coefficients. Systems of finite aperture and small field are discussed, and the generalized sine condition is obtained. The analysis includes aberrations of electron-optical systems. W.T.Welford

535.31

1237. PROJECTIVE FORMULATION OF THE PROBLEMS OF GEOMETRICAL OPTICS. I. THEORETICAL FOUNDATIONS. E.Cambi.
J. Opt. Soc. Amer., Vol. 49, No. 1, 2-15 (Jan., 1959).

A procedure is described and discussed, by which the requirements imposed on an optical system can be formulated in terms of the unknown surfaces, so that conditional (differential) equations can be written as a basis for the design. This is made possible through a projective transformation by which any ray is represented as a point of a mapping plane, referred by duality to the physical plane of the optical trajectory. In the first part of the paper, after a general statement of the problem, a summary is given of the principal results of projective geometry that are utilized in the discussion; next, the differential equation of a refracting or reflecting surface is deduced and discussed in dual terms.

535.31

1238. PROJECTIVE FORMULATION OF THE PROBLEMS OF GEOMETRICAL OPTICS. II. THE DESIGN OF A CENTERED OPTICAL SYSTEM. E.Cambi.
J. Opt. Soc. Amer., Vol. 49, No. 1, 15-30 (Jan., 1959).

As an application of the theoretical procedure suggested in the preceding abstract, the design of a general optical system is considered. In order that the formulation may be useful, the general equations deduced in Pt I, which merely expressed the classic laws of geometrical optics, should be supplemented by a number of equations expressing the elimination of the principal aberrations: this requires that a literal "ray tracing" be effected. In the tangential plane, this projective ray tracing is merely an application of elementary principles: in the extrameridian case, an artifice is introduced by which points and lines of a tridimensional space can be mapped in a plane through the use of complex coordinates. Though the discussion of such complex mapping requires some supplementary theory to be developed, the extrameridian ray tracing can eventually be performed without greater difficulty than that encountered in the tangential case. The conclusions are illustrated by the discussion of the design of a general Schmidt system.

535.31 : 535.4

1239. ON A COMPARISON BETWEEN WAVE OPTICS AND GEOMETRICAL OPTICS BY USING FOURIER ANALYSIS. III. IMAGE EVALUATION BY SPOT DIAGRAM. K.Miyamoto.
J. Opt. Soc. Amer., Vol. 49, No. 1, 35-40 (Jan., 1959).

For Pt I see Abstr. 5745 (1958). Spot diagrams give much information about the image formation of an optical system. In order to evaluate the image qualities of lenses quantitatively, it is shown that the geometric optical response function and the intensity distribution can be calculated directly from the coordinates of the spots. Image evaluation using the geometric optical "Strehl definition" is also discussed. Furthermore, the relation between wave optics and geometrical optics is considered in the case of partial coherence, and it is deduced that, when the wave aberration function is large compared with the wavelength (more than $2\lambda$), the degree of coherence in the object plane scarcely affects the intensity distribution in the image plane.

535.31

1240. GENERALIZED OBJECT–IMAGE RELATIONSHIPS IN OPTICAL SYSTEMS. H.Dlutzik.
Optik, Vol. 14, No. 7-8, 345-52 (July-Aug., 1957). In German.

Starting from general ray congruences, the condition of orthogonality is applied to give generalizations of the Helmholtz–Lagrange theorem for skew pencils. W.T.Welford

535.31

1241. CALCULATION OF THE WAVE-SURFACE CORRESPONDING TO A PENCIL OF RAYS. R.Stettler.
Optik, Vol. 15, No. 7, 407-13 (July, 1958). In German.

The longitudinal aberration of a meridional pencil is expressed as a power series in the convergence angle. From this, parametric equations for the wavefront are obtained as series of which the terms are given by recurrence relations. The optical path difference between the principal ray and any other is obtained, together with the shape of the caustic. W.T.Welford

535.314

1242. AUTOMATIC RAY TRACING USING THE IBM 704. M.Laikin.
J. Opt. Soc. Amer., Vol. 48, No. 9, 666-7 (Sept., 1958).

Meridional rays are traced by a trigonometrical scheme in which three square root operations replace references to tables. A numerical example is given. W.T.Welford

535.314

1243. RAY TRACING THROUGH A LENS OF CIRCULAR CROSS SECTION. V.M.Papadopoulos.
J. Opt. Soc. Amer., Vol. 48, No. 9, 667 (Sept., 1958).

A graphical method for determining refracted and reflected rays at a spherical surface. W.T.Welford

535.317

1244. NUMERICAL DETERMINATION OF THE FACTOR OF ENCIRCLED ENERGY RELATIVE TO A DIFFRACTION PATTERN OF REVOLUTION. G.Lansraux and G.Boivin.
Canad. J. Phys., Vol. 36, No. 12, 1696-709 (Dec., 1958).

An optical system which is symmetrical about some axis forms a diffraction pattern around its focus F in an observation plane Π. The factor of encircled energy E(W) is, apart from a normalization factor, the energy spread over the Π plane inside a circle of radius W, centred on F. Although it is a good test for the quality of an optical system, the factor of encircled energy has not been used a great deal because of the lengthy calculations that its numerical determination requires. Two rapid computing methods are given here, with tables allowing a complete determination of E(W).

535.317

1245. SOME EXPERIMENTS ON IMAGE QUALITY IN PHOTOGRAPHIC LENSES. D.F.Carr.
J. photogr. Sci., Vol. 6, No. 4, 107-11 (July-Aug., 1958).

Measurements of resolving power, line profile, edge profile and frequency response are reported for a $10\frac{1}{4}$ inch, F/4.5 photographic objective, used in conjunction with a fine grain film. W.T.Welford

535.317

1246. ON THE MEASUREMENT OF THE OPTICAL CONTRAST TRANSFER FUNCTION. A.Lohmann.
Optik, Vol. 14, No. 11, 510-18 (Nov., 1957). In German.

Two methods are given: (1) moiré fringes are used to provide a sine grating of variable spacing which is imaged by the lens under test; the transfer function is displayed on an oscillograph as a function of spatial frequency; (2) birefringent shearing interferometers of the Savart plate and Wollaston prism types are used as analogue computors by integrating the light flux in the interference pattern. W.T.Welford

535.317

1247. ON THE DESIGN OF TRIPLET OBJECTIVES. F.I.Havliček.
Optik, Vol. 15, No. 7, 448-50 (July, 1958). In German.

An algebraic solution for the thin-lens Cooke triplet, starting from given glass types and using the conditions of zero distortion and transverse and longitudinal chromatic aberration. W.T.Welford

535.317.1

1248. GENERAL SOLUTION OF THE LUNEBERG LENS PROBLEM. S.P.Morgan.
J. appl. Phys., Vol. 29, No. 9, 1358-68 (Sept., 1958).

The general solution is obtained for the index of refraction of a variable-index, spherical lens which will form perfect geometrical images of the points of two given concentric spheres on each other. One conjugate sphere is assumed to be outside the lens or at its surface, while the other may be either inside, outside or at the surface. If one of the spheres is of infinite radius, the lens will focus a parallel beam perfectly at a point on the other sphere. It is shown that the index of refraction may be specified arbitrarily, subject to two simple conditions, in an outer shell of any desired thickness less

than the radius of the lens. The index of the central portion is then expressed in terms of a function which is tabulated, and of an integral involving the index of the outer shell. Some properties of the general solution are discussed, and various special solutions are derived.

535.317.2

1249. THE OCCURRENCE OF MULTIPLE IMAGE PLANES IN A PHOTOGRAPHIC OBJECTIVE. J.Kämmerer.
Optik, Vol. 14, No. 9, 399-410 (Sept., 1957). In German.

In a real lens having residual aberrations, more than one image plane of sharpest definition may be found. These planes are investigated for a photographic objective, as a function of the lens aperture. The number and position of these image planes is found to be independent of the aperture and they are proved to correspond with the positions of the maxima of the Strehl definition. R.W.Fish

535.317.5

1250. A NOTE ON CONCENTRIC OPTICAL SYSTEMS. C.Morais.
Atti Fond. Ronchi, Vol. 13, No. 4, 337-56 (July-Aug., 1958). In Italian.

Optical systems having a centre of symmetry have been widely used in reflecting instruments, but rather infrequently in refracting systems. The theory of refracting symmetrical systems is derived, including 5th order aberrations. A typical example is given to illustrate the procedure for obtaining freedom from aberration. R.W.Fish

535.317.5

1251. NOTES UPON A PARTICULAR CONCENTRIC OPTICAL SYSTEM. C.Morais.
Atti Fond. Ronchi, Vol. 13, No. 5, 462-8 (Sept.-Oct., 1958). In Italian.

A concentric optical system, in which the inner component has a continuously variable index, is known to give good correction up to f/0.5. The present paper investigates the condition for good spherical aberration correction when this inner component is replaced by a lens of uniform refractive index. A typical example is calculated in detail. R.W.Fish

535.317.5 : 535.24

1252. THE INFLUENCE OF SPHERICAL ABERRATION AND COMA ON THE ILLUMINATION IN THE IMAGE OF A LAMBERT RADIATOR. H.Slevogt.
Optik, Vol. 15, No. 2-3, 111-15 (Feb.-March, 1958). In German.

If a Lambert radiator is imaged by an optical system, the illumination on the surface of a suitably chosen sphere in the image space is uniform provided the system is coma-free, but freedom from spherical aberration is not necessary. The effect of spherical aberration and coma on the illumination of planes perpendicular to the axis is studied. W.T.Welford

535.317.6

1253. THE RELATIONSHIP BETWEEN THE EXTRA-AXIAL DISK OF CONFUSION AND THE AXIAL CORRECTION OF AN OPTICAL INSTRUMENT. H.Köhler.
Optik, Vol. 14, No. 5, 202-20 (May, 1957). In German.

Calculations using Seidel theory show that, in the case of telescopes, the extra-axial disk of confusion may be reduced in size by over-correcting on the axis. In practical cases, an improvement off the axis can be achieved without serious deterioration of the axial image. A number of objectives are calculated and the improvements verified by photographs of the star images. R.W.Fish

535.317.7 : 535.83

1254. NOTES ON THE CORRECTION OF DISTORTION IN TELESCOPES. H.Köhler.
Optik, Vol. 14, No. 6, 241-55 (June, 1957). In German.

An investigation to determine whether correction should be for constancy of the ratio of the tangents of the field angles (condition 1), or of the angles themselves (condition 2). Experiments showed that if straight lines are to be imaged by binoculars as straight lines then condition 1 must be fulfilled, but if the binoculars are then used to sweep across a field the image appears to move across a curved surface (image buckling). This was eliminated if condition 2 was satisfied, but then straight lines no longer appeared straight. Conditions 1 and 2 are mutually exclusive. W.T.Welford

535.322

1255. REFRACTOMETER FOR CONTINUOUS PROCESS-STREAM ANALYSIS. L.G.Glasser and D.J.Troy.
Industr. engng Chem., Vol. 50, No. 8, 1149-52 (Aug., 1958).

A stainless steel cell is described suitable for use in a continuous process. The complete optical system resembles a prism spectroscope, with compensating plates rotating to balance deviations due to changes of refractive index. The motion of the compensating plate can be coupled to a recorder to give a continuous record of index. The system is sensitive to index changes of $4 \times 10^{-6}$, corresponding to a change in composition of 0.01%. Practical details and 13 references are given. R.W.Fish

535.323 : 537.226.2

OPTICAL PROPERTIES OF SYNTHETIC CALCIUM TITANATE CRYSTAL. See Abstr. 275

535.324

1256. ADIABATIC PIEZO-OPTIC COEFFICIENTS OF LIQUIDS. (ETHYL ACETATE, METHYL ACETATE, AMYL ACETATE AND CYCLOHEXANOL). C.K.Narayanaswamy.
J. Indian Inst. Sci. A, Vol. 39, No. 2, 113-24 (April, 1957).

The method of Raman and Venkataraman (Proc. Roy. Soc., Vol. 171, 137, 1939) was used. The temperature variation of the refractive index of the above liquids was also studied using a Pulfrich refractometer. The data are discussed with reference to deviations from refraction formulae, the temperature coefficient of refractive index at constant density, and the relation between the adiabatic and the isothermal piezo-optic coefficients.

535.33.07 : 535.34.07

1257. NEAR INFRARED SPECTRA WITH SODIUM CHLORIDE OPTICS. W.H.Washburn and M.J.Mahoney.
Appl. Spectrosc., Vol. 12, No. 4, 127-8 (1958).

For investigations in the range 0.7 to 3.0 $\mu$, the advantages of using a sodium chloride prism in a standard double-beam instrument are described. G.I.W.Llewelyn

535.33.07

1258. A HIGH-INTENSITY MIRROR DOUBLE MONOCHROMATOR. R.Havemann, A.Gamon and H.Ernst.
Exper. Tech. der Phys., Vol. 1, No. 4-5, 192-7 (Nov.-Dec., 1953). In German.

The instrument has an aperture ratio 1 : 4.1, f = 300 mm. A resolution of about ±1 A is obtained. C.Turner

535.33.07 : 535.81

1259. STRAY-LIGHT MEASUREMENTS ON A ZEISS SPECTROPHOTOMETER. F.Fröhlich.
Exper. Tech. der Phys., Vol. 4, No. 5, 231-40 (1956). In German.

A method is described for measuring the stray light passing through a spectrophotometer and for determining its wavelength. The practical results are given in detail. R.W.Fish

535.33.07

1260. AN ALTERNATING-BEAM SPECTROPHOTOMETER. R.V.Hesketh.
J. sci. Instrum., Vol. 35, No. 10, 371-4 (Oct., 1958).

An alternating-beam system has been added to a Unicam type SP. 500 spectrophotometer for work over the wavelength range 2000-10 000 A. In the visible spectrum a change of optical density of 0.0007 may be detected with an illumination intensity of $10^8$ quanta per second and a response time of 20 sec. The additional system is of simple construction and provides a means of measuring optical absorptions when the presence of other radiation prohibits the use of a single-beam instrument.

535.33.07

1261. THE DOUBLE MIRROR AS A MEANS OF ASSISTING THE EXACT IMAGING OF LIGHT SOURCES FOR SPECTRAL ANALYSIS. R.Mannkopff.
Optik, Vol. 14, No. 7-8, 303-6 (July-Aug., 1957). In German.

Behind the light source on the optical axis of the spectrograph is a projection lens, then a 90° prism to reflect the beam vertically upwards, followed by a plane mirror to return the beam parallel to the axis, but at a higher level. An enlarged image of the source is formed at eye-level above the spectrograph. S.T.Henderson

535.33.07

1262. A NEW MONOCHROMATIC FILTER FOR THE MERCURY LINE 4358 A. H.Fesefeldt and H.Krappatsch.
Optik, Vol. 14, No. 7-8, 307-18 (July-Aug., 1957). In German.

Describes filter for the isolation of the Hg line 4358 A. Achieved purity versus spectral transmittance at 4358 A is plotted and compared with the corresponding curves of two other known filters.

535.33.07

1263. MINIMUM LIGHT CRITERION WITH GRATING SPECTROGRAPHS. D.Hauk and A.Lohmann.
Optik, Vol. 15, No. 5, 275-7 (May, 1958). In German.

The principle previously used with a prism spectrometer (see

Abstr. 6601/1953) to give a dark centre to each spectral line was tried with a grating. The latter was made by photographic reduction of a drawing having a half-space at the centre, thus slipping the phase of one half of the grating by $\pi$. G.F.Lothian

535.33.07

1264. A VACUUM SPECTROGRAPH FOR SPECTROCHEMICAL EMISSION ANALYSIS IN THE FAR ULTRAVIOLET.
J.Romand and B.Vodar.
Rev. Opt., Vol. 37, No. 7, 329-35 (July, 1958). In French.

The authors give a brief review of the difficulties encountered with the usual spectrochemical analysis methods for the detection of the elements having their sensitive lines in the far ultraviolet. One of the solutions of this problem is provided by the use of the vacuum sliding spark spectrum, and the authors describe an apparatus especially designed for this purpose. The main component is a vacuum grating spectrograph, which is useful for all spectral investigations in the range 500-2900 A.

535.33.07

1265. A VACUUM SPECTROGRAPH FOR THE SCHUMANN REGION. G.Milazzo.
R.C. Ist. Super. Sanita, Vol. 19, No. 12, 1167-74 (1956). In Italian.

The instrument is equipped with a 1 m concave grating of 1200 lines/mm, and a ruled surface 40 × 80 mm in an Eagle mounting. This spectrograph differs from other similar types by the optical (vacuum-tight) separation of the part in which the plate is located from that which contains the grating. The former being of a much smaller volume, the evacuation time following every plate change is considerably reduced.

535.331

1266. NEW EXTREME ULTRAVIOLET LINES IN THE SPECTRUM OF Nb II. L.Iglesias.
An. Real Soc. Espan. Fis.Quim., Vol. 53(A), No. 11-12, 249-52 (Nov.-Dec., 1957).

A complete list of lines of the second spectrum of niobium (Nb II) would be very useful in the interpretation of stellar spectra. In order to extend the actual information, new measurements, ranging from 2199 to 1296 A, were carried out. Wavelengths and estimated relative intensities are presented here for 592 lines, 470 of them being observed for the first time.

535.332/.333

1267. SPECTRUM OF NITROGEN BETWEEN 0.9$\mu$ AND 2.6$\mu$.
G.Hepner and L.Herman.
Ann. Geophys., Vol. 13, No. 3, 242-8 (1957). In French.

Results of the emission spectra of atomic and molecular nitrogen are presented in detail. Several new bands of the system $B^3\Pi$-$A^3\Sigma$ were identified and from measurements of the relative intensities the concentrations of $N_2$ molecules of different vibrational levels have been determined. G.I.W.Llewelyn

535.332

1268. THE ENHANCEMENT BY ARGON OF THE INTENSITY OF THE RESONANCE RADIATION OF MERCURY VAPOUR, EXCITED BY THE CONTINUOUS SPECTRUM FROM A HYDROGEN LAMP.
J.L.Cojan and Y.Lécluse.
C.R. Acad. Sci. (Paris), Vol. 247, No. 17, 1327-30 (Oct. 27, 1958). In French.

The resonance radiation of mercury vapour, ($\lambda$ = 2537 A), was observed using a hydrogen lamp as a source. It was found that the intensity of this radiation is increased by the introduction of argon into the mercury vapour. A graph is shown of the increase of intensity with increase of the partial pressure of argon, and a theoretical discussion of the results is given. R.D.Hudson

535.332

1269. SHOCK-TUBE STUDY OF LUMINOSITY IN XENON.
W.Roth and P.Gloersen.
J. chem. Phys., Vol. 29, No. 4, 820-4 (Oct., 1958).

Shock waves in xenon producing temperatures in the range 6000-11 000°K have been found to result in emission of a visible continuum after an induction period. An activation energy for continuum emission has been found to correspond to the energy of the metastable state of the xenon atom. This energy can only be associated with visible continuum emission if ground state and metastable state atoms interact to form stable diatomic molecules in an excited state which subsequently make dissociative transitions to a repulsive ground state.

535.337

1270. SHIFTS OF ARC LINES AT VARIOUS PRESSURES IN MAGNETIC FIELDS. R.A.Miller.
Nature (London), Vol. 182, 1295-6 (Nov. 8, 1958).

Briefly describes measurements of line shifts (to the red) found for certain Zn and Cu lines in high-pressure (250-1250 lbs/sq in.) high-voltage nitrogen arcs with and without a magnetic field of 4000 gauss. The shifts vary from about 0.05 to 0.6 A. A qualitative explanation is given in terms of space-charge forces which, it is suggested, counteract the van der Waals pressure broadening when a magnetic field is applied. J.D.Craggs

535.338.334

1271. SIMPLIFIED QUANTUM-MECHANICAL THEORY OF PRESSURE BROADENING. M.Baranger.
Phys. Rev., Vol. 111, No. 2, 481-93 (July 15, 1958).

Quantum mechanics is used to treat the motion of the perturbers broadening a line. Several simplifying assumptions are made, such as the Born—Oppenheimer approximation, and the assumption of no degeneracy. These assumptions can be removed. Also made is the "impact approximation", which is essential for the validity of the results and cannot be removed. With it, the line has a Lorentz shape, and its width and shift are expressed in terms of the two scattering amplitudes of the perturbers by the atom in its upper and lower state. The case where the perturbers do not interact appreciably with the lower state is particularly simple. Then, the width and shift are proportional to the imaginary part and the real part of the forward scattering amplitude, respectively. A quantity called the "collision volume" is defined. It is shown that the impact approximation is valid if the collision volume is much smaller than the volume per perturber. There is a second validity condition, which has no classical analogue.

535.338.334

1272. PROBLEM OF OVERLAPPING LINES IN THE THEORY OF PRESSURE BROADENING. M.Baranger.
Phys. Rev., Vol. 111, No. 2, 494-504 (July 15, 1958).

The theory of pressure broadening is re-examined, in order to include the possibility of overlapping lines, which are a regular feature of pressure broadening in an ionized gas. It is found that a simple treatment can be given using the impact approximation. This approximation is examined in detail, and its validity conditions are discussed. When it is valid, it is permissible to replace the exact time-dependent interaction between the atom and the perturbers by a time-independent effective interaction. The latter is not Hermitian, however, and therefore every level acquires a width. The shape of a group of overlapping lines is then worked out, and is found to consist of a sum of Lorentz line shapes, plus some interference terms. In the particular case of an isolated line, the results given previously by Anderson are obtained. Finally, a study is made of the simplifications brought about by rotational invariance.

535.338.334

1273. THEORY OF LINE BROADENING IN MULTIPLET SPECTRA
A.C.Kolb and H.Griem.
Phys. Rev., Vol. 111, No. 2, 514-21 (July 15, 1958).

A theory of line broadening in the impact approximation is developed which includes the case of overlapping lines. It is assumed that the collisions which give rise to the broadening do not cause transitions between states with different principal quantum numbers. The theory is worked out in detail in two cases: (1) the broadening arises only from perturbations of the upper state with arbitrary splitting of the substates. This approximation may be used if the perturbations of the lower state are relatively unimportant (e.g. the higher series members of the Balmer lines), and is exact if the perturbations do not affect the lower state as in the case of the ground state of hydrogen perturbed by electron collisions; (2) complete degeneracy of the initial and final states. This approximation is also valid on the far wing of the line if there is splitting, i.e. for frequencies large compared to the splitting, and is a generalization of Anderson's theory. The formal theory is worked out by two different methods. The method of calculation for nearly degenerate initial and final states with splitting is indicated. Method I is particularly suited for calculating the wing distribution while Method II is more suitable for finding the intensity distribution at the line centre for overlapping lines. The line profile is made up of a sum of dispersion profiles and asymmetric terms which arise from interferences when the transition operator is not diagonal. The shift and half-width parameters are found from the roots of a secular equation and depend on the splitting as well as the density, temperature, and the character of the perturbation.

535.338.334

1274. REDUCING THE DOPPLER WIDTH OF SPECTRAL LINES. M.E.Zhabotinskiĭ, V.F.Zolin and Yu.L.Sverdlov.
Radiotekhnika i Elektronika, Vol. 2, No. 8, 1082 (1957). In Russian.

Gives an expression for the dependence of spectral line width in the centimetre band on the pressure, taking into account the atomic weights and effective collision diameters of the examined and auxiliary gases. R.C.Glass

535.34

1275. THE INTENSITY DISTRIBUTION OF A CERTAIN INTERCOMBINATION BAND. I.Kovács and O.Scari.
Acta phys. Hungar., Vol. 8, No. 4, 425-35 (1958). In German.

With the help of base eigenfunctions obtained from a five-electron model, the intensity distribution of all branches of the intercombination bands ${}^6\Sigma^{\pm} - {}^2\Sigma^{\pm}$, ${}^6\Sigma^{\pm} - {}^2\Sigma^{\mp}$ are found. The energy level scheme for the 36 possible branches is exhibited in detail. It is hoped that this work may help in the analysis of the spectrum of vanadium oxide. R.O.Davies

535.34 : 539.19

TRANSITION PROBABILITIES AND MOLECULAR EXCITATION. See Abstr. 732

535.34.07

1276. MICROSAMPLING FOR SMALL INFRARED SPECTROPHOTOMETERS. J.U.White, S.Weiner, N.L.Alpert and W.M.Ward.
Analyt. Chem., Vol. 30, No. 10, 1694-8 (Sept., 1958).

A three-lens beam condenser was built for the sample space of Beckman i.r. spectrophotometers. It passes 75% of the light through a $0.5 \times 4$ mm sample area by forming a fivefold reduced image of the slit and then remagnifying it. Small capillary absorption cells of this size have been used to measure the spectra of a number of essential oil samples on a small double beam spectrophotometer. Potassium bromide pellets ($1 \times 5$ mm) were pressed for solid samples. Polarization measurements are possible on the small samples using a rotatable polarizer.

535.34.07

1277. CRITERIA DETERMINING THE DESIGN AND PERFORMANCE OF A SOURCE-MODULATED MICROWAVE CAVITY SPECTROMETER. R.W.R.Hoisington, L.Kellner and M.J.Pentz.
Proc. Phys. Soc., Vol. 72, Pt 4, 537-44 (Oct., 1958).

An analysis is given of the radio- and audio-frequency modulation method employed in microwave spectroscopy. The results of the theory are compared with measurements taken on a 8 mm microwave spectrometer and are found to be in close agreement. The calculations are extended to include the case where an absorbing gas is enclosed in a resonant cavity.

535.34.07

1278. MICROMODULATOR — A DEVICE FOR MEASURING THE INTENSITIES OF MICROWAVE ABSORPTION LINES.
R.D.Mattuck and M.W.P.Strandberg.
Rev. sci. Instrum., Vol. 29, No. 8, 717-21 (Aug., 1958).

The device requires only a small electromagnet and power supply and utilizes a free electron resonance to provide a standard comparison line at any frequency from 0 to 40 kMc/s. Preliminary tests carried out on ammonia at K-band indicate reproducible results with errors of less than ±30% in most cases. Suggestions are made for improving the accuracy of the measurements.

535.343

1279. ABSORPTION SPECTRUM OF RUBIDIUM IN THE PRESENCE OF ISOMERIC HYDROCARBONS.
O.Jefimenko and J.A.Gwinn.
J. chem. Phys., Vol. 29, No. 1, 148-50 (July, 1958).

Absorption spectra of Rb in the presence of various hydrocarbons (ethylene, propylene, butene-1, isobutylene, isobutane, n-pentane, isopentane, neopentane, n-hexane, 3-methylpentane, 2,3-dimethylbutane, and neohexane) were studied for the purpose of determining the dependence of the collision-induced satellite bands on the structure of colliding particles. It was found that the positions of the low-temperature red bands are regularly affected by the differences in structure of the hydrocarbon molecules. In particular, the least branched (straight chain) isomeric molecules produce bands with the smallest band-line separations, and the most branched molecules with four or three methyl groups attached to the same carbon atom produce bands with the largest band-line separations. On the other hand, the positions of the high-temperature red bands as well as the positions of the violet bands are not noticeably affected by the differences in molecular structure of the hydrocarbon isomers employed in this work.

535.343 : 539.19

1280. THE SPECTRUM AND STRUCTURE OF THE HNO MOLECULE. F.W.Dalby.
Canad. J. Phys., Vol. 36, No. 10, 1336-71 (Oct., 1958).

The absorption spectrum of HNO in the region 6500-7700 A was photographed on a 35 ft grating. The observed spectrum consists of three bands: an intense one at the long-wavelength end of the spectrum and two weaker bands towards shorter wavelengths. All the bands have extensive rotational structure of the perpendicular type. The spectrum was observed after the flash photolysis of nitromethane, nitroethane, isoamyl nitrite, and mixtures of nitric oxide and ammonia. The "lifetime" of the HNO was about 1/10 sec under these experimental conditions. The spectrum of DNO was also photographed. From the constants obtained from the rotational analysis the molecular geometry has been determined. For the lower electronic state

$$r''_{NO} = 1.211_6 \text{ A}, \quad r''_{NH} = 1.062_8 \text{ A}, \text{ and } \angle HNO = 108.5_8^\circ.$$

For the upper electronic state

$$r'_{NO} = 1.241_1 \text{ A}, \quad r'_{NH} = 1.036_0 \text{ A}, \text{ and } \angle HNO = 116.2_8^\circ.$$

The most probable identification of the observed electronic transition is ${}^1A'' \leftarrow {}^1A'$.

535.343

1281. EFFECTS OF HYDROSTATIC PRESSURE ON THE INTENSITY OF THE SINGLET-TRIPLET TRANSITION OF α-CHLORONAPHTHALENE IN ETHYL ICDIDE.
W.W.Robertson and R.E.Reynolds.
J. chem. Phys., Vol. 29, No. 1, 138-41 (July, 1958).

The extinction coefficient of the singlet—triplet transition of alpha-chloronaphthalene in ethyl iodide is found to increase almost linearly with the density of the compressed mixture. Study of a 1 :2 volume ratio of these components over a pressure range from 1 to 3644 atm resulted in about a two-fold increase in light absorption, with little other changes in band envelope. No increase in absorption coefficient was obtained for pure liquid aplha-chloronaphthalene subjected to comparable increase in hydrostatic pressure. The increase in extinction coefficient is attributed to the increase in collisional frequency resulting from the increase in concentration of the constituents and the corresponding decrease in the liquid "cage" dimensions with increased density.

535.343

1282. FIELD-INDUCED ABSORPTION IN HYDROGEN.
M.F.Crawford and R.E.MacDonald.
Canad. J. Phys., Vol. 36, No. 8, 1022-39 (Aug., 1958).

Reports an investigation of the fundamental rotation-vibration absorption induced in hydrogen by an electric field. The integrated absorption coefficients of the first four components of the Q branch were measured for a range of field strengths at densities of 83.9 and 44.6 amagat. The integrated absorption coefficient of the S(1) line was determined at the higher density for one high field strength. The relative intensities of the Q components are in good agreement with the predicted ratios. Accurate experimental values of the matrix element of the mean value of the polarizability, $(\alpha)_{01}$, and the matrix element of its anisotropy, $(\gamma)_{01}$ were obtained. They are: $(\alpha)_{01} = 0.968 \times 10^{-25}$ cm$^3$, and $(\gamma)_{01} = 0.72 \times 10^{-25}$ cm$^3$ at 83.9 amagat, and are only slightly dependent on density. The frequencies of the lines were measured. Only Q(1) and S(1) show a measurable shift with density. The optical collision diameter was determined and is very small, 0.26 A.

535.343

1283. INFRARED SPECTRA OF THE ALKALINE-EARTH HALIDES. I. BERYLLIUM FLUORIDE, BERYLLIUM CHLORIDE, AND MAGNESIUM CHLORIDE. A.Büchler and W.Klemperer.
J. chem. Phys., Vol. 29, No. 1, 121-3 (July, 1958).

The infrared spectra of $BeF_2$, $BeCl_2$ and $MgCl_2$ in the vapour phase were measured. Both the asymmetric stretching mode $\nu_3$ and the bending mode $\nu_2$ were observed for each of these compounds. The observed frequencies are

| | $BeF_2$ | $BeCl_2$ | $MgCl_2$ |
|---|---|---|---|
| $\nu_3$ | 1520 | 1113 | 597 cm$^{-1}$ |
| $\nu_2$ | 825 | 482 | 295 |

Two bands of the gaseous dimer $Be_2Cl_4$ were also observed. Examination of the bending force constants shows that the bonds in the dihalides are strongly directional. The bond stretching force constants of these dihalides are almost identical in magnitude with those of the corresponding monohalides BeF, BeCl and MgCl.

535.343

1284. INFRARED ABSORPTION OF CYANOGEN IN THE CESIUM IODIDE REGION AND CN BOND MOMENT. T.Miyazawa.
J. chem. Phys., Vol. 29, No. 2, 421-4 (Aug., 1958).

A spectrometer with cesium iodide optics was built, and used to measure the $\nu_5$ bands of the normal and $C^{13}$-enriched cyanogen. By the use of molecular data, the thermodynamic functions of cyanogen are calculated. The bending frequencies and normal modes are calculated by a normal coordinate treatment. The absolute intensity of the $\nu_5$ band was measured and the derivative of dipole moment with respect to the symmetry coordinate was determined. On the assumption of independent rigid bond model the effective CN bond moment is calculated to be 1.2 D.

535.343

1285. VIBRATIONAL SPECTRUM OF DISILYL SULFIDE. H.R.Linton and E.R.Nixon.
J. chem. Phys., Vol. 29, No. 4, 921-4 (Oct., 1958).

The infrared and Raman spectra of both $SiH_3SSiH_3$ and $SiD_3SSiD_3$ are reported. Interpretation of the gas and liquid spectra indicates a value of about $100^0$ for the SiSSi angle. The low-temperature infrared spectra suggest a $C_{3v}$ symmetry for the molecule in the crystal.

535.343

1286. INFRARED SPECTRA OF PARTIALLY DEUTERATED DIBORANES. W.J.Lehmann, J.F.Ditter and I.Shapiro.
J. chem. Phys., Vol. 29, No. 6, 1248-56 (Dec., 1958).

Infrared spectra, in the 2 to 15 $\mu$ range, of equilibrium mixtures of various proportions of $B_2H_6$ and $B_2D_6$ are reported. These mixtures contain twenty-one different species (represented by seven molecular formulae ranging from $B_2H_6$ to $B_2D_6$), which exist in equilibrium with one another and cannot be separated by chemical or physical means. However, the spectra of the individual formula groups $B_2D_5H$ and $B_2H_5D$ were obtained by spectroscopically compensating for other species present in the equilibrium mixtures. An assignment of the observed and unobserved fundamental frequencies of the four molecules represented by the two formulae is made with the help of previously published data on $B_2H_6$ and $B_2D_6$ and by application of the noncrossing rule and the product and sum rules. Comparison with published spectra of partially deuterated ethylenes and dimethylaminodiborane support these assignments.

535.343

1287. ENHANCEMENT OF INFRARED ABSORPTION BANDS OF CHARGE TRANSFER COMPLEXES. E.E.Ferguson and F.A.Matsen.
J. chem. Phys., Vol. 29, No. 1, 105-7 (July, 1958).

An enhancement of infrared absorption bands is shown to be inherent in charge transfer theory due to change in vertical ionization energy or change in vertical electron affinity during the course of molecular vibration. A semiquantitative calculation of the intensity enhancement of the symmetric ring stretching vibrational mode of benzene in the benzene–iodine complex agrees well with the experimentally observed value. This result shows that previous investigators' assumptions of charge-transfer complex asymmetry, based on observed infrared absorption bands may not be valid.

535.343

1288. SPECTRA OF HOMOLOGOUS SERIES OF MONOSUBSTITUTED AMIDES. M.Beer, H.B.Kessler and G.B.B.M.Sutherland.
J. chem. Phys., Vol. 29, No. 5, 1097-104 (Nov., 1958).

Infrared spectra of the pure liquid and of dilute solution were observed for N-methyl, N-ethyl, N-propyl, and N-butyl acetamides and propionamides and of N-deuterated N-butylacetamide. Also infrared spectra of $N^{15}$-butylacetamide and N-deuterated $N^{15}$-butylacetamide and the Raman spectra of N-butylacetamide and N-deuterated N-butylacetamide were observed. In each series a band in the higher members were related to each band of the N-methyl compound on the basis of similarity in frequency, intensity, bandwidth, and the influence of dilution. In N-methylacetamide and N-butylacetamide bands thus related were found to have also similar Raman activities and similar shifts on replacing the peptide hydrogen by deuterium. The extra bands could be related systematically to the extra $CH_2$ groups. The implications of these results in protein spectroscopy and in the spectroscopic study of homologous series is discussed.

535.343

1289. GROUND-STATE INVERSION SPECTRUM OF $N^{14}D_3$. G.Herrmann.
J. chem. Phys., Vol. 29, No. 4, 875-9 (Oct., 1958).

The inversion spectrum of $N^{14}D_3$ was investigated between 1500 and 1620 Mc/s. A revised formula for the rotational fine structure was obtained to fit 17 observed lines. Splitting of K = 3 lines into two components was found in good agreement with predicted values. Nitrogen satellites were observed and the values $(eQq)_N$ = = 4080±3 kc/s and a = 2±2 kc/s were assigned to the nitrogen quadrupole and magnetic coupling constants, respectively. Hyperfine structure due to removal of the K degeneracy was observed in K = 1 lines. Applying the theory of Hadley, calculated and observed line contours were brought into agreement. Assuming cylindrical symmetry about bonds, the value $(eQq)_D$ = 200±20 kc/s was obtained for the deuteron quadrupole coupling constant. A value $\epsilon$ = 1.9±0.5 kc/s was obtained for the magnetic coupling constant between deuteron spins and molecular rotation.

535.343

1290. RELATIVE INTENSITIES OF MICROWAVE ABSORPTION LINES. P.H.Verdier and E.B.Wilson, Jr.
J. chem. Phys., Vol. 29, No. 2, 340-7 (Aug., 1958).

A method is described for measuring the relative intensities of microwave absorption lines up to 80 Mc/s apart, to within a few per cent, using a Stark-modulated resonant cavity absorption cell of novel design. Barriers to internal rotation in $CH_2CHO$ and $CH_3CH_2F$ were obtained by measuring the relative intensities of torsional satellites. The resulting barrier heights are: 1103 ± 60 cal for $CH_3CHO$, 3310 ± 210 cal for $CH_3CH_2F$, in good agreement with the values 1162 ± 30 cal for $CH_3CHO$, and 3306 ± 100 cal for $CH_3CH_2F$ obtained from splitting measurements by Kilb, Lin, and Wilson, and by Herschbach, respectively. Correction factors are given for errors in intensity and splitting measurements due to small doublet splittings.

535.343

1291. MICROWAVE SPECTRA OF MOLECULES EXHIBITING INTERNAL ROTATION. IV. ISOBUTANE, TERTIARY BUTYL FLUORIDE, AND TRIMETHYLPHOSPHINE. D.R.Lide, Jr and D.E.Mann.
J. chem. Phys., Vol. 29, No. 4, 914-20 (Oct., 1958).

For Pt III, see Abstr. 2242 (1958). Several microwave transitions of $(CH_3)_3CH$, $(CH_3)_3CF$ and $(CH_3)_3P$ were measured and assigned. Rotational constants $B_0$ for the three molecules are 7789.45, 4712.15, and 5816.24 Mc/s, respectively. Molecular structures and dipole moments were determined. The $(CH_3)_3CF$ structure indicates an unusually long CF bond. The prominent satellite lines are assigned to excited vibrational states; the $l$-type doubling pattern of transitions in degenerate states is fitted to theory. Vibrational frequencies determined from relative intensity measurements agree with infrared and Raman results but indicate an incorrect species assignment in $(CH_3)_3P$. Frequencies of the torsional vibrations are used to derive information of the potential function for internal rotation. The leading Fourier coefficient in this function is 3900, 4300 and 2600 cal/mole, respectively, for $(CH_3)_3CH$, $(CH_3)_3CF$, and $(CH_3)_3P$. The terms representing interactions among the $CH_3$ groups are much smaller.

535.343 : 539.19

MICROWAVE SPECTRUM OF METHYL MONOFLUOROSILANE. See Abstr. 724

535.343 : 535.375.5

1292. OPTIMUM CONCENTRATION EFFECT IN RAMAN SPECTROSCOPY. E.R.Lippincott, J.P.Sibilia and R.D.Fisher.
J. Opt. Soc. Amer., Vol. 49, No. 1, 83-9 (Jan., 1959).

The optimum concentration technique for increasing the intensity of the Raman spectrum of a coloured substance is considered in detail. Intensity–concentration data are given for a number of Raman lines. An optimum concentration for a maximum in observed Raman intensity is shown to exist for each of the Raman lines examined. An expression is derived relating the observed Raman intensity with the molar concentration of a solution of absorbing substance in a transparent solvent by consideration of the absorption of both the exciting radiation and the scattered radiation. The agreement between the theoretical curves and the experimental points is good. More experimental data are necessary to further check the theoretical expression. The best technique for obtaining the Raman spectra of coloured substances is to use excitation radiation which will not be absorbed and which will not cause photochemical decomposition. When light sources which emit such radiation are not available, the optimum-concentration technique is shown to be a possible alternative method for obtaining a Raman spectrum.

535.343 : 535.375.5

1293. STUDY OF THE EXPERIMENTAL FACTORS AFFECTING RAMAN BAND INTENSITIES IN LIQUIDS. D.G.Rea.
J. Opt. Soc. Amer., Vol. 49, No. 1, 90-101 (Jan., 1959).

The various instrumental factors which affect both peak and

integrated Raman band intensities in liquids are discussed. These factors include the refractive index, colour, and temperature of the sample; slit function and spectral sensitivity of the spectrophotometer; and the convergence and line width of the exciting radiation. Procedures for applying corrections for these factors relative to the 459 $cm^{-1}$ band of carbon tetrachloride are presented. These considerations will allow good relative band areas to be obtained and will facilitate the interchangeability of peak intensity data between different laboratories.

535.343.9 : 535.375.5

1294. RAMAN SPECTRUM OF CRYSTALLINE POWDERS.
J.L.Cojan and A.Renaux.
C.R.Acad. Sci. (Paris), Vol. 247, No. 15, 1111-13 (Oct. 13, 1958).
In French.

The powders are immersed in a liquid of similar refractive index, irradiated with 4358 A through a filter of $I_2$ in $CCl_4$ to remove longer $\lambda$'s. A filter before the slit consisting of solutions of KI and $K_4HgI_2$ reduces the transmission of 4358 A. Spectrograms are shown for barium nitrate, cinnamic acid and benzoic acid.

G.F.Lothian

535.343.9 : 535.375.5

1295. EXCITATION OF RAMAN SPECTRA IN THE ULBRICHT SPHERE. G.Bergmann and G.Thimm.
Naturwissenschaften, Vol. 45, No. 15, 359 (1958). In German.

The Ulbricht sphere can be used for solutions, with the advantage that 80 watts can be used instead of 1500 watts, because of multiple reflections on the walls, while the continuum of the lamp is considerably reduced by the interference filter. C.Turner

535.343.9 : 535.375.5 : 535.371

1296. ON THE SIMULTANEOUS OBSERVATION OF RAMAN SCATTERING OF LIGHT AND OF FLUORESCENCE.
P.P.Shorygin and T.M.Ivanova.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 1, 70-3 (1958). In Russian.

Experiments with dilute solutions of nitroaminostilbenes irradiated in their absorption regions (near 23 000 $cm^{-1}$) showed that both Raman and fluorescence radiation could be observed simultaneously. Possible mechanisms are discussed. C.H.L.Goodman

535.345 : 539.2

1297. EXPERIMENTAL AND THEORETICAL STUDY OF THE SHAPE OF THE F ABSORPTION IN KCl.
J.J.Markham and J.D.Konitzer.
J. chem. Phys., Vol. 29, No. 3, 673-4 (Sept., 1958).

Results show that the F absorption band in KCl is not symmetrical and is neither Lorenzian nor Gaussian. Variation of the square of the half width with temperature is as coth $(h\nu/2kT)/T$ with $\nu = 2.95 \times 10^{12}$ $sec^{-1}$ which disagrees with previous values. The data obtained indicate the need of a re-examination of interaction of electrons with normal lattice modes in polar solids.

G.F.J.Garlick

535.345

1298. ABSORPTION SPECTRA IN MOLTEN SALT SOLUTIONS.
J.Greenberg and B.R.Sundheim.
J. chem. Phys., Vol. 29, No. 5, 1029-32 (Nov., 1958).

The absorption spectra of solutions of alkali halides and of halogen gases in alkali halide eutectic melts are described. The spectra of the halides are interpreted as charge transfers from the anion. The halogens are shown to dissolve in these solvents to form trihalide ions.

535.345 : 551.521.3

1299. RADIATION RECEIVED BY AN UNCOLLIMATED RECEIVER FROM A $4\pi$ SOURCE. M.G.Gibbons.
J. Opt. Soc. Amer., Vol. 48, No. 8, 550-5 (Aug., 1958).

The influence of field of view on measurements of atmospheric transmission of visible radiation is considered in this paper. The relative amounts of scattered visible radiation received from a $4\pi$ source by an uncollimated receiver when both source and receiver are immersed in a uniform atmosphere, are computed as a function of receiver acceptance angle for a range of receiver acceptance angles from $0^0$ to $180^0$, and for types of atmospheric scattering which are characteristic of an extremely clear atmosphere, a hazy atmosphere, and a murky atmosphere. The ranges of optical thickness (path length times attenuation coefficient) for which calculations are made with these types of scattering are 0.033 to 1.2, 0.1 to 3.6, and 0.3 to 10.8 respectively. The atmosphere is assumed to be infinite in extent, and only single scattering is taken into account. For the case of a hazy atmosphere, the actual ratio of the amounts of direct and scattered-in radiation received is also computed for the given for the ranges of optical thickness and acceptance angle, and is compared with experimental results published by other investigators and preliminary experimental results obtained by the writer.

535.345 : 539.2

1300. THEORY OF THE BETA BAND IN ALKALI HALIDE CRYSTALS. R.Fuchs.
Phys. Rev., Vol. 111, No. 2, 387-9 (July 15, 1958).

It is shown that the $\beta$ band in alkali halides with the NaCl lattice consists of six components. Their energies are estimated in NaCl. It is suggested that the observed $\beta$ band is the component with the lowest energy and that the other components are not easily observed because they lie in the fundamental band. The calculated oscillator strength is 0.10, which is probably too small by a factor of 5. The final state for the $\beta$-band transition undergoes autoionization with the rate $1.8 \times 10^{13}$ $sec^{-1}$. The width of the $\beta$ band is increased by only 0.012 eV or about 10% by this process.

535.345

1301. TEMPERATURE DEPENDENCE OF OPTICAL ABSORPTION IN P-TYPE INDIUM ARSENIDE. F.Matossi and F.Stern.
Phys. Rev., Vol. 111, No. 2, 472-5 (July 15, 1958).

The absorption maximum near 0.17 eV found in p-type InAs at $300^0$K shifts to lower energies at lower temperatures, and to a stationary value of 0.19 eV above $430^0$K. The peak absorption coefficient has a minimum value near $370^0$K and increases with increasing and decreasing temperatures. The observed absorption agrees with theoretical expectation provided a term linear in wave vector is included in the energy near the centre of the Brillouin zone. Analysis of the data suggests that the energy maximum of the valence band lies 0.003 ± 0.003 eV above the energy at the centre of the zone, that the spin–orbit splitting is 0.43 eV, and that the density-of-states effective mass of the heavy-hole band is approximately 0.41m at energies well below the top of the band. The temperature coefficient of the intrinsic energy gap above room temperature is about −0.000 33 eV/deg K for an absorption coefficient of 40 $cm^{-1}$.

535.345

1302. ABSORPTION SPECTRUM OF KCl:Tl AT LOW TEMPERATURES. D.A.Patterson.
Phys. Rev., Vol. 112, No. 2, 296-7 (Oct. 15, 1958).

The ultraviolet absorption spectrum of thallium in single-crystal potassium chloride was accurately measured down to 187 m$\mu$ at $295^0$, $77^0$, and $4^0$K. The asymmetry apparent in both major bands at room temperature disappears at low temperature. The existence of two kinds of singlet thallium centres in slightly different crystalline environments is suggested as a possible explanation.

535.345 : 539.12 : 537.531

LIGHT ABSORPTION COEFFICIENTS OF INHOMOGENEOUS MATERIALS. See Abstr. 331

535.345 : 538.222

OPTICAL INVESTIGATION OF SILICATE GLASSES AND FUSED SILICA COLOURED BY X-RAYS. See Abstr. 452

535.37

1303. TRANSFER OF TRIPLE STATE ENERGY IN SOLUTION.
G.Porter and M.R.Wright.
J. Chim. phys., Vol. 55, No. 9, 705-12 (Sept., 1958).

Pulse excitation of the luminescence of anthracene and naphthalene in solution and study of decay of emission indicates a mixture of first- and second-order processes in decay of the triplet state. Non-radiative quenching effects are discussed and new results given for the quenching by paramagnetic ions. G.F.J.Garlick

535.37

1304. LUMINESCENCE AND INCORPORATION OF FLUORINE IN VANADIUM PHOSPHORS. K.T.Wilke and H.Kotschy.
Z. phys. Chem. (Leipzig), Vol. 208, No. 5-6, 375-7 (April, 1958).
In German.

Earlier work on luminescent vanadates is summarized. Barium, zinc and magnesium vanadates made with excess of metal oxide fluoresce under long ultraviolet. The orange emission of the Mg compound is increased by incorporation of fluoride to give $5MgO.MgF_2.V_2O_5$, whereas the yellow emission of $3ZnO.V_2O_5$ is diminished by fluoride. S.T.Henderson

535.371

1305. ON CERTAIN CHROMATIC ASPECTS OF THE PHOTOLUMINESCENCE OF A ZnS:Cu. J.P.Leroux and P.Thureau.
C.R. Acad. Sci. (Paris), Vol. 247, No. 13, 924-6 (Sept. 29, 1958).
In French.

It was observed that the relative intensity of the blue (465 m$\mu$) and the green (535 m$\mu$) emission bands of a ZnS:Cu powder phosphor, excited by u.v. radiation, depends on the intensity of excitation, and on the thickness (surface density) of the powder. As the thickness is increased, the intensity of the green emission increases more rapidly than that of the blue emission, indicating that the latter is preferentially absorbed. J.B.Birks

535.371

1306. NEW U.V. PHOSPHORS.
H.Witzmann, R.Müller and G.Semisch.
Exper. Tech. der Phys., Vol. 5, No. 6, 281-3 (1957). In German.

A table summarises the emission details of numerous silicates, phosphates and other compounds activated by Pb, Tl or $Ce^{3+}$. The new phosphors are borates of Be, Mg, Ca, Sr and Ba of composition $3MeO:4H_3BO_3$ and about 0.01% Pb before firing. Their peak emission is between 3400 and 3800 A, while Be, Ca and Sr produce a second band near 2800 A. Detailed emission curves are given for the Ca and Sr compounds. The latter has a strong peak near 2850 A promoted by lower Pb contents, with a maximum intensity at 0.005% Pb, and with more Pb the band at 3700 A predominates, its maximum intensity occurring at 0.007% Pb. S.T.Henderson

535.371

1307. DELAYED SINGLET–SINGLET EMISSION FROM MOLECULAR CRYSTALS. N.W.Blake and D.S.McClure.
J. chem. Phys., Vol. 29, No. 4, 722-4 (Oct., 1958).

The fluorescence emission from the molecular crystals naphthalene and phenanthrene may be observed after a delay of several milliseconds from the time of excitation. The decay time is strongly temperature dependent and the decay law is nonexponential. The delayed emission is connected with the crystalline state of the material, but is not otherwise understood.

535.371

1308. INFLUENCE OF OXYGEN ON THE TRANSFER EFFICIENCY AND FLUORESCENT YIELD OF ORGANIC SOLUTIONS.
V.Bar and A.Weinreb.
J. chem. Phys., Vol. 29, No. 6, 1412-14 (Dec., 1958).

The quenching action of oxygen on the transfer efficiency and fluorescent yield of organic solutions is investigated in systems in which the transferring solvent is undiluted and in systems in which it is diluted by an inert solvent. It is shown that quenching by oxygen is a process competing with energy transfer from the solvent to the solute, with emission of solute fluorescence, and with self-quenching of the solute. Experimental evidence for the assumption that transfer of energy takes place by a direct interaction between excited solvent molecules and accepting solute molecules is augmented.

535.371

1309. TEMPERATURE DEPENDENCE OF FLUORESCENCE OF TIN-ACTIVATED ORTHOPHOSPHATES. R.W.Mooney.
J. Electrochem. Soc., Vol. 105, No. 8, 456-61 (Aug., 1958).

Apparatus for measuring the temperature dependence of fluorescence is described. The variation of fluorescent intensity with temperature as a function of tin-activator concentration is given for the systems: strontium–zinc orthophosphate and strontium–calcium orthophosphate. In both cases, the quenching temperature is independent of activator concentration. The results are interpreted in terms of Johnson and Williams' theory of fluorescent quenching.

535.371

1310. TRANSFER OF ENERGY IN LIQUID AND RIGID ORGANIC SYSTEMS. F.H.Brown, M.Furst and H.P.Kallmann.
J. Chim. phys., Vol. 55, No. 9, 688-97 (Sept., 1958). In French.

The fluorescence characteristics of different organic solutions, liquid and solid, are compared for $\gamma$-ray excitation, excitation by light absorbed in the solvent and by light absorbed directly in the fluorescent solute. The transfer of energy is similar for light and for $\gamma$-rays at low solute concentrations by $\gamma$-ray excitation produces a more efficient transfer at high solute concentrations. It is assumed that in this case higher excited states are involved but in general the lowest excited states of solvent molecules are the most important in the transfer process. Rigid and liquid solutions are similar in behaviour with respect to the transfer. G.F.J.Garlick

535.371

1311. CONTROL OF LUMINESCENCE BY CHARGE EXTRACTION.
P.J.Daniel, R.F.Schwarz, M.E.Lasser and L.W.Hershinger.
Phys. Rev., Vol. 111, No. 5, 1240-4 (Sept. 1, 1958).

It has been discovered that the application of a potential of a few volts to phosphors of the ZnS group can quench the fluorescence. The effect was observed in single-crystal and recrystallized wafers of the phosphors by illuminating one side with nonpenetrating light and applying a field, through suitable contacts, normal to the illuminated surface. With the illuminated surface negative, the fluorescence is reduced by an amount dependent on the voltage for as long as the voltage is maintained, and total extinction can often be obtained. The luminescent output follows variations in the applied voltage up to a maximum frequency which depends on the fluorescence time constant. The effect is shown to be a fundamental property of phosphor materials possessing large differences in hole and electron mobilities or capture cross-section. It is explained in terms of a decrease in the excess electron density due to the extraction of holes from the illuminated surface by the field. A simple mathematical theory is proposed which accounts in detail for the observed effects and which predicts current–voltage relationships which have been confirmed experimentally.

535.371

1312. FLUORESCENCE OF AZULENE IN THE VAPOUR PHASE.
G.R.Hunt and I.G.Ross.
Z. Naturforsch., Vol. 11a, No. 12, 1043 (1956). In German.

The fluorescence spectrum of azulene vapour, excited by a r.f. discharge, was measured. The ground state and first excited state of the azulene molecule appear to cross. J.Franks

535.371

1313. FLUORESCENCE MEASUREMENTS ON ANTHRACENE VAPOUR. K.H.Härdtl and A.Scharmann.
Z. Naturforsch., Vol. 12a, No. 9, 715-19 (1957). In German.

The fluorescence of anthracene vapour excited by long ultraviolet was measured at concentrations up to $8 \times 10^{-3}$ moles/litre, and at temperatures between 220° and 340° C. A mean quenching constant of 300 l/(mole cm) was found for the higher concentrations. At the lowest concentration, the decay time was $4.3 \times 10^{-9}$ sec, rising to a maximum value for intermediate concentrations in the range studied. No polarization of the emission was observed. Absorption and emission spectra of anthracene vapour at low pressure were measured in detail. Both showed banded structure. S.T.Henderson

535.371 : 535.375.5 : 535.343.9

ON THE SIMULTANEOUS OBSERVATION OF RAMAN SCATTERING OF LIGHT AND FLUORESCENCE. See Abstr. 1296

535.372

1314. FLUORESCENCE SPECTRA, TERM ASSIGNMENTS, AND CRYSTAL FIELD SPLITTINGS OF RARE EARTH ACTIVATED PHOSPHORS. S.P.Keller.
J. chem. Phys., Vol. 29, No. 1, 180-7 (July, 1958).

The visible fluorescent emissions, excited by 280 m$\mu$ radiation, of SrS phosphors, singly activated with rare earth ions, was determined. These spectra are correlated with atomic term signature designations and with spectra of rare earth salt compounds. Crystal field splittings of certain energy levels are observed.

535.372

1315. FLUORESCENCE SPECTRUM OF $PrCl_3$ AND THE LEVELS OF THE $Pr^{+++}$ ION. G.H.Dieke and R.Sarup.
J. chem. Phys., Vol. 29, No. 4, 741-5 (Oct., 1958).

$PrCl_3$ shows strong fluorescence from the $^3P_0$, $^3P_1$, and $^1D$ levels to all low lying levels of the $Pr^{+++}$ ion ($^3H$, $^3F$, $^1G$). This makes it possible to obtain all multiplet components of $^3H$ and $^3F$. Previously unreported lines in the absorption spectrum are interpreted as transitions to the hitherto unknown $^1I_6$. Zeeman effect data corroborate this. All levels to be expected from a $4f^2$ configuration are now known for $PrCl_3$ except $^1S_0$ which should give a line in a

535.372.08

1316. DIRECT RECORDING OF FLUORESCENCE EXCITATION SPECTRA. C.A.Parker.
Nature (London), Vol. 182, 1002-4 (Oct. 11, 1958).

Fluorescence excitation spectra, i.e. fluorescence output per unit frequency interval per quantum, provide more sensitive indicators of fluorescent solute concentrations than absorption spectra. A spectrofluorimeter is described giving the time excitation spectrum. A fluorescent substance with quantum yield independent of frequency over the desired range is used with a photomultiplier to monitor the intensity of exciting light from a monochromator and the signal is presented with that for the unknown fluorescent solute to a ratio recorder. G.F.J.Garlick

535.373

1317. TRANSFER OF ENERGY BETWEEN TRIPLET LEVELS.
V.Ermolaev and A.Terenin.
J. Chim. phys., Vol. 55, No. 9, 698-704 (Sept., 1958). In French.

Earlier comparison of sensitized phosphorescence in frozen solutions of aromatic hydrocarbons with sensitized fluorescence of dye molecules is revoked, substantial differences between the two phenomena having been found (Abstr. 6533/1956). In aldehydes and ketones containing naphthyl or diphenyl groups the phosphorescence spectrum is similar to that of naphthalene or diphenyl respectively, its excitation being interpreted as due to intermolecular energy transfer between triplet levels of the carbonyl and of the naphthyl or diphenyl groups respectively. G.F.J.Garlick

535.376 : 621.385.832

1318. NOTES ON THE CATHODOLUMINESCENCE EFFICIENCY OF ZINC SULPHIDE TYPE PHOSPHORS. G.Gergely.
J. Electronics and Control, Vol. 5, No. 3, 270-2 (Sept., 1958).

It is concluded that energy conversion efficiencies in cathode-ray tube phosphor screens (≅21%) approach the estimated theoretical limit, although quantum efficiencies for photoluminescence can be greater (≅90%). The difference is attributed to non-radiative energy losses of primary and secondary electrons which appear to be independent of primary electron velocities over a wide range.

G.F.J.Garlick

535.376 : 539.17 : 539.1.07

SCINTILLATION RESPONSE OF CsI(Tl) CRYSTALS TO FISSION FRAGMENTS. See Abstr. 490

535.376 : 539.1.07

1319. RESPONSE OF A LIQUID SCINTILLATOR TO FAST NEUTRONS AND $\gamma$ RADIATION. J.E.Hardy.
Rev. sci. Instrum., Vol. 29, No. 8, 705-9 (Aug., 1958).

The response of a commercially available liquid scintillator to $D(d,n)He^3$ neutrons and to $\gamma$-radiation from several standard sources was measured. It is found that the pulse-height response to $\gamma$-ray energy is linear in the energy range from 0.5 to 2.6 MeV, and that the fast neutron detection efficiency of a disk scintillator 5 cm thick is about 30% in the neutron energy range from 2 to 3.5 MeV, and varies with neutron energy E as

$$\xi(E) = 0.146 + 0.45/E + 0.82,$$

where E is measured in MeV.

535.376

1320. THE ELECTROLUMINESCENCE OF ZINC SULPHIDE PHOSPHORS AS AN EQUILIBRIUM PROCESS. W.Lehmann.
Optik, Vol. 14, No. 7-8, 319-27 (July-Aug., 1957). In German.

The high local fields required for electroluminescence are due to the presence of very small regions of good conductivity in a badly conducting crystal. A theory of equilibrium between a monomolecular excitation and a recombination process, using several simplifying assumptions, leads to a relation between time average of intensity L and field F of the form $L = A \exp(-B/F)$, in agreement with experiment. The theoretical temperature dependence of electroluminescence is discussed, and its modification by thermal quenching. Experimental results are shown to fit a plot of the type expected, revealing three trap depths. S.T.Henderson

535.376

1321. ELECTROLUMINESCENCE OF ZnS SINGLE CRYSTALS WITH CATHODE BARRIERS. D.R.Frankl.
Phys. Rev., Vol. 111, No. 6, 1540-9 (Sept. 15, 1958).

Certain ZnS crystals show electroluminescence predominantly near the cathode. The major emission from Cu-activated crystals occurs as a burst of light when the exciting voltage is suddenly removed, as electrons flowing back toward the cathode to neutralize the barrier charge recombine with ionized luminescent centres. This burst may be quenched by a voltage in the opposite direction. There is also a small steady component of emission due either to capture of electrons that entered the crystal from the cathode or to excitation of centres to discrete levels. In Mn-activated crystals, only the latter has been observed. These results, as well as the emission peaks obtained from copper-activated ZnS under sinusoidal voltage excitation, are explained in terms of ionization of luminescent centres in a barrier region. The "primary" peak, which predominates in powder samples and under low voltages in single crystals with metal contacts, is due to recombination of centres left over from the previous half-cycle. A capture cross-section of about $10^{-12}$ cm$^2$ is deduced. The peak at about 150 to 170 phase degrees is due to recombination of ionized centres left in the neutral part of the crystal as the barrier width diminishes. A barrier space-charge density of (very roughly) $10^{16}$ e/cm$^3$ is deduced. The in-phase is analogous to d.c. electroluminescence.

535.376

1322. THE PREPARATION OF ELECTROLUMINESCENCE PHOSPHORS. G.Wendel.
Z. phys. Chem. (Leipzig), Vol. 206, No. 1-2, 169-74 (Nov., 1956). In German.

Known methods of preparation are discussed, and some of the author's experiments described, showing the importance of the presence of ZnO in the phosphors. S.T.Henderson

535.377

1323. THERMOLUMINESCENCE OF LIMESTONES AND CALCITES AND ITS SIGNIFICANCE ON ORE-SEARCH. N.Hayakawa.
Technol. Rep. Tohoku Univ., Vol. 22, No. 2, 187-207 (1958).

535.379

1324. SONOLUMINESCENCE. P.Jarman.
Sci. Progr., Vol. 46, 632-9 (Oct., 1958).

Comprehensive review of experimental and theoretical work. 38 references.

535.379

1325. SONOLUMINESCENCE EXPERIMENTS.
P.Günther, E.Heim, A.Schmitt and W.Zeil.
Z. Naturforsch., Vol. 12a, No. 6, 521-2 (1957). In German.

Measurements of the sonoluminescence emission of aqueous and organic solutions of gases showed that the light flash occurs at the end of the ultrasonic compression phase. The duration of the flash is less than $10^{-7}$ sec. J.Franks

535.39

1326. TRANSMITTANCE AND REFLECTANCE OF CESIUM IODIDE IN THE FAR INFRARED REGION.
E.K Plyler and N.Acquista.
J. Opt. Soc. Amer., Vol. 48, No. 9, 668-9 (Sept., 1958).

The percentage transmittance for the range 40-90 $\mu$ is given, with that of quartz for comparison. The reflectance was measured up to 170 $\mu$ and is shown to have a relatively sharp maximum at 145 $\mu$. R.W.Fish

535.39

1327. OPTICAL PROPERTIES OF CRYSTALLINE BORON.
W.G.Spitzer and W.Kaiser.
Phys. Rev. Letters, Vol. 1, No. 7, 230-2 (Oct. 1, 1958).

Single crystals with a carrier concentration of $10^{13}$ cm$^{-3}$ showed an absorption edge at 1 micron and several absorption bands between 4 and 13 microns. The stronger bands are believed to be due to lattice absorptions. Reflectivity curves show anomalous dispersion near 21 microns, and indicate a dielectric constant of 8.4 at short wavelengths and 10.0 at wavelengths longer than 25 microns.

C.Hilsum

535.392

1328. THE COLOUR OF THIN OXIDE FILMS ON METALS.
A.M.MacSwan.
Proc. Phys. Soc., Vol. 72, Pt 5, 742-8 (Nov., 1958).

The colours observed when white light is reflected from metals covered with a thin oxide film are considered, and a theory of selective transmission of light into the metal is developed. The Smith Chart is used to calculate the variation of the composition of the reflected light with the thickness of the oxide film.

535.393

1329. OPTICAL CONSTANTS OF SOME THIN LAYERS OF GOLD.
R.Philip.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1104-8 (Oct. 13, 1958). In French.

The coefficients n and k were determined for wavelengths 5085, 4358 and 2967 A and for thicknesses 0-100 m$\mu$. The coefficient n passed through a sharp maximum for a thickness 2-3 m$\mu$, and k through a much broader maximum between 30 and 50 m$\mu$. B.T.M.Willis

535.393

1330. THE OPTICAL PROPERTIES OF SO-CALLED HOCHHEIM ALLOYS. K.Krebs and R.Winkler.
Optik, Vol. 14, No. 11, 503-9 (Nov., 1957). In German.

The reflectivity and transmissivity of various Al–Ag alloys (Al containing 3 to 12% Ag) were investigated at wavelengths of 578, 435 and 365 m$\mu$. The investigations showed that the reflectivity of films of these alloy (the transmissivities being equal) is invariably less than that of pure Al and decreases with increasing Al content. The explanation is that owing to the large excess of Al, mixture phases of Al–Ag are invariably formed which have lower reflectivities than the pure metals Al and Ag.

535.41

1331. STUDY OF INTENSITY DISTRIBUTION IN MULTIPLE-BEAM INTERFERENCE. W.Blanke and A.Lohmann.
Optik, Vol. 14, No. 7-8, 361-8 (July-Aug., 1957). In German.

The effect of the finite extension of the source and the out-of-phase effect in the first beam when using reflected multiple-beam interference fringes is studied, both theoretically and experimentally. It is confirmed that a saw-tooth intensity distribution is produced. This has a negligible effect in interference topographic studies involving height differences. There is an effect if the absolute separation of two interference surfaces is required. The interference minimum should be employed, since it is least sensitive to displacement. S.Tolansky

535.412

1332. CONCERNING THE VISIBILITY AND LOCALIZATION OF WEDGE INTERFERENCE FRINGES. R.Landwehr.
Z. Naturforsch., Vol. 13a, No. 1, 58-9 (Jan., 1958). In German.

The calculation is made, and the results shown graphically, for both phase displacement and visibility of fringes produced in a wedge, in so far as these are influenced by the convergence of the incident beam. The cases treated range from that of the interference comparator in which the angles are very small to that of the interference microscope with high aperture in which the angles are large.

S.Tolansky

535.412

1333. DEPENDENCE OF THE CONTRAST ON APERTURE DIAMETER OF THE FIZEAU FRINGES IN THE MICHELSON INTERFEROMETER. G.Hansen and W.Kinder.
Optik, Vol. 15, No. 9, 560-4 (Sept., 1958). In German.

This is an extension and correction to an article by Hansen (Abstr. 3647/1955), dealing with the visibility of Twyman interferometer fringes. Values for intensities and positions of maxima and minima are computed. The case considered is that in which mirrors are inclined to give Fizeau fringes and then the ring system is re-established by introduction of a small rectangular aperture. The dependence of visibility on this aperture and its position is studied.

S.Tolansky

535.412

1334. COHERENCE REQUIREMENTS FOR INTERFEROMETRY. G.D.Kahl and F.D.Bennett.
Rev. mod. Phys., Vol. 30, No. 4, 1193-6 (Oct., 1958).

A generalized treatment of fringe visibility in two-beam interferometers, taking account of the spectral composition of the source, effective variations of this with angle due to a prism in one beam, and source size. An extension of a previous treatment (Abstr. 2300/1957) is indicated.

W.T.Welford

535.417 : 531.715

1335. ERRORS IN THE MEASUREMENT OF FILM THICKNESS BY MULTIPLE-BEAM INTERFEROMETRY. C.Weaver and P.Benjamin.
Nature (London), Vol. 182, 1149-50 (Oct. 25, 1958).

It is shown that an error in estimating thin-film thickness by interferometry can arise, if the step edge is produced on the film by a scratching technique. The substrate (glass) can be deformed appreciably, to an extent depending on the scratching load. Even light loads of as low as 5 gm can induce error of as much as 18 A, and a 100 gm load leads to a 273 A error. This method of scratching the film is considered unsatisfactory.

S.Tolansky

535.417 : 531.715

1336. SOME POSSIBLE APPLICATIONS OF THE INTERFEROMETER USING CORRELATED RAYS. R.Ullrich and W.Lochte-Holtgreven.
Optik, Vol. 14, No. 11, 481-9 (Nov., 1957). In German.

A discussion of two-beam interferometer systems in which two beams cover a given cycle in opposite directions and then recombine. A difference in space coverage is indicated according to whether an odd or even number of reflections is involved. Systems are described for use as (a) a refractometer, (b) an interferometric system in which fringes and object are superposed, and (c) an interference length comparator.

S.Tolansky

535.417 : 531.717.3

1337. OPTICAL APPARATUS FOR DEPTH SENSING. U.Gerhardt.
Optik, Vol. 15, No. 2-3, 132-4 (Feb.-March, 1958). In German.

An interference microscope was used to determine the distance between two nearly coplanar parallel faces of two metal end gauges wrung together. Using both white light and monochromatic light, accuracy of a fraction of a micron is claimed. Observations could be made at up to 70 cm from the gauges.

W.T.Welford

535.417 : 531.715 : 539.25

THREE DIMENSIONAL MICROSCOPY. See Abstr. 863

535.417 : 531.259.2

MEASUREMENTS OF QUENCHING STRESSES IN A BEARING RING BY INTERFERENCE FRINGES. See Abstr. 1116

535.42 : 534.321.9

1338. DIFFRACTION OF LIGHT BY ULTRASONIC WAVES — OBLIQUE INCIDENCES. S.Parthasarathy and C.B.Tipnis.
Nature (London), Vol. 182, 1083-4 (Oct. 18, 1958).

Experimental results are quoted for the intensity distribution for various orders of diffracted light, and these are found to agree with published theory.

E.A.Mussett

535.42 : 534.321.9

1339. DIFFRACTION OF LIGHT BY WEAK ULTRASONIC FIELDS. B.Ramachandra Rao and J.Satyanarayana Murty.
Z. Phys., Vol. 152, No. 4, 440-7 (1958).

Assuming the validity of Raman and Nath's (1935-36) simplified theory for small widths of weak sound fields, an elegant and simple method is presented to derive an expression for the intensity of the first order in the case of weak sound fields. Expressions obtained are found to be identical with those of David (Abstr. 4631/1937), and Bhatia and Noble (Abstr. 1212-13/1954). Extending this treatment to the case of diffraction by stationary waves it is shown that the intensity of a first order in this case is half that of the corresponding order for progressive waves. This result has also been verified experimentally.

535.42

1340. ON THE DIFFRACTION THEORY OF WAVEFRONTS WITH ONLY ONE PLANE OF SYMMETRY. H.Slevogt.
Optik, Vol. 14, No. 9, 377-87 (Sept., 1957). In German.

The complex amplitude at the pupil is expressed as a double series of Zernike circle polynomials, and from this a double series is derived for the complex amplitude in the image of a point. A simple expression for the Strehl definition is obtained.

W.T.Welford

535.42 : 534.39

1341. ON RELATION BETWEEN SPECTRAL NUMBER AND ULTRASONIC WATTAGE FROM RAMAN AND NATH'S THEORY. K.Samal.
Proc. Nat. Inst. Sci. India A, Vol. 24, No. 3, 177-81 (1958).

Raman and Nath's relationship for the distribution of intensity of light diffracted by ultrasonic waves in liquids was critically studied, with a view to finding out the relation between the observed spectral number and ultrasonic wattage. It is shown that no explicit relationship is obtainable and a graphical representation based on any particular minimum intensity for observation is possible. The graphical relation is non-linear for smaller-order numbers and is linear for higher-order numbers.

535.43

1342. LIGHT-SCATTERING BY CHARGED DISLOCATIONS IN IONIC CRYSTALS. C.A.Plint, O.Theimer and W.A.Sibley.
Ann. Phys. (New York), Vol. 5, No. 4, 342-56 (Dec., 1958).

The temperature dependence of light-scattering by single crystals of sodium chloride and potassium chloride is investigated in the temperature region between 168° and 350°K. In contrast to the predictions of earlier theories, pronounced maxima and minima of the scattering intensity are observed. It is shown that the general scattering theory recently developed by the authors (Abstr. 3904/1958) explains the experiments quantitatively if the scattering regions are interpreted as vacancy and impurity clouds surrounding charged dislocations (see Abstr. 1322/1958). No other plausible scattering mechanism appears to be compatible with the experiments.

535.43

1343. THE SCATTERING OF LIGHT BY SPHERICAL AND ROD-SHAPED PARTICLES OF WAVELENGTH ORDER OF MAGNITUDE. R.Burberg.
Z. Naturforsch., Vol. 11a, No. 10, 807-19 (1956). In German.

Formulae are developed for the evaluation of light-scattering measurements on the suspensions of large viruses and similar biological material. In particular, correction terms to the Debye formula for the scattered intensity (see Abstr. 1502/1947) for the two most important particle shapes - spheres and rods - are computed, and the error in applying this formula to other shapes is estimated. It is assumed that the incident wave is linearly polarized.

T.P.Brody

535.434

1344. THEORETICAL INVESTIGATIONS ON THE LIGHT SCATTERING OF COLLOIDAL SPHERES. IV. SPECIFIC TURBIDITIES IN THE LOWER MICROSCOPIC RANGE AND FINE STRUCTURE PHENOMENA. W.Heller and H.J.McCarty.
J. chem. Phys., Vol. 29, No. 1, 78-80 (July, 1958).

For Pt III, see Abstr. 7031 (1957). Additional calculations were carried out on the scattering cross-sections of spheres and the specific turbidities of their dispersed systems using again the Mie theory. The parameters considered were $\alpha$ = 7.0 (0.2) 25.6 and m = 1.05 (0.05) 1.30. The close spacing of the $\alpha$ values allowed for the detection of a fine structure of regular period in the $(\tau/c)_0(\alpha)$ curves and related curves. The fine structure is explained as the result of interferences of secondary magnitude.

535.434

1345. EFFECT OF ANISOTROPY ON LIGHT SCATTERING BY STREAMING FREELY FLEXIBLE LINEAR MACROMOLECULES. A.F.Stevenson and H.L.Bhatnagar.
J. chem. Phys., Vol. 29, No. 6, 1336-9 (Dec., 1958).

The theory of Peterlin, Heller, and Nakagaki is generalized to allow for each segment of the macromolecule possessing two different polarizabilities, one longitudinal and the other transverse. The polarization of the scattered light is then different from that given by the theory of P.H.N., which predicts the polarization to be that of ordinary Rayleigh scattering. Expressions for the four different differential cross-sections which can be defined are derived.

535.514.2

1346. MEASUREMENT OF THE DEGREE OF POLARIZATION WITH THE HELP OF A COMPENSATING SET OF GLASS PLATES.II. A.Kawski.
Optik, Vol. 14, No. 6, 260-2 (June, 1957). In German.

For Pt I, see Abstr. 6075 (1957). The measurement was investigated both theoretically and experimentally, achieving agreement between theory and experiment. The influence of absorption is shown to be negligible.

535.55 : 537.228.4

1347. PHOTOELECTRIC ARRANGEMENT OF GREAT SENSITIVITY FOR THE MEASUREMENT OF THE KERR ELECTRO-OPTIC EFFECT. J.Rabinovitch and M.Rouzeyre.
C.R.Acad. Sci. (Paris), Vol. 247, No. 4, 441-2 (July 28, 1958). In French.

Brief details are given of an arrangement for measuring small values of birefringence such as arise in the Kerr electro-optic effect. The sensitivity is considered to be about 300 times better than that achieved by visual methods. H.G.Jerrard

535.551

1348. THE DISPERSION OF THE STRESS OPTICAL COEFFICIENT OF VITREOUS SILICA. E.S.Jog.
J. Indian Inst. Sci. A, Vol. 39, No. 2, 93-100 (April, 1957).

The coefficient C and its variation with wavelength were determined over the range from 230 to 500 m$\mu$. A formula for the dispersion of C is given which is valid from 230 to 650 m$\mu$.

535.551

1349. STRESS-OPTICAL BEHAVIOR OF SYNTHETIC PERICLASE (MgO). A.A.Giardini and E.Poindexter.
J. Opt. Soc. Amer., Vol. 48, No. 8, 556-7 (Aug., 1958).

The stress-birefringence constants of synthetic periclase were measured by the photometric integration-technique. The measured results for the difference constants are $q_{1111}-q_{1122} = -1.25 \times 10^{-13}$ cm$^2$ dyne$^{-1}$ and $2q_{1212} = -0.66 \times 10^{-13}$ cm$^2$ dyne$^{-1}$. The absolute constants were determined by the prism deviation method; the values are $q_{1111} = -0.9 \times 10^{-13}$ cm$^2$ dyne$^{-1}$ and $q_{1122} = 0.3 \times 10^{-13}$ cm$^2$ dyne$^{-1}$. The dispersion of the difference constants throughout the visible spectrum is about 2%, in opposite directions. No hysteresis effect was observed for pressures up to 8000 lb/in$^2$. The results are discussed briefly with reference to bond structure.

535.551 : 534.213

ULTRASONIC STRESS BIREFRINGENCE IN QUARTZ. See Abstr. 1186

535.6

1350. ACCURACY OF TRISTIMULUS COMPUTATIONS. G.W.Ingle.
J. Opt. Soc. Amer., Vol. 48, No. 10, 761 (Oct., 1958).

Three recommendations are made for the calculation of accurate tristimulus values. R.A.Weale

535.7

PHYSIOLOGICAL OPTICS. VISION. See also the Section entitled "BIOPHYSICS. PHYSIOLOGICAL PHYSICS".

535.81

1351. SELECTION OF OPTICAL GLASSES IN TAYLOR TRIPLETS (GENERAL METHOD). N.v.d.W.Lessing.
J. Opt. Soc. Amer., Vol. 49, No. 1, 31-4 (Jan., 1959).

A method for the choice of glasses in Taylor triplets, in which the glasses of the first and third lenses are different, is described. By using the conditions for total power, longitudinal chromatic aberration, Petzval sum, transverse chromatic aberration, and distribution of power between the first and third lenses, an equation for the power of the second lens in terms of the glass constants is derived. This equation forms the basis of the method, by which a glass combination is obtained giving a small power for the second lens. The length of the objective and the position of the diaphragm are taken into consideration during selection. A condition of distortion is also satisfied.

535.81

1352. A TWO CO-ORDINATE LIGHT POINTER AND ITS APPLICATION TO A RECORDING INTERFEROMETER. H.G.Kuhn and H.J.Lucas-Tooth.
J. sci. Instrum., Vol. 35, No. 11, 413-15 (Nov., 1958).

A light pointer is described which allows the deflections of two mirrors to be recorded in a two coordinate graph. This is used in a direction-recording Fabry–Perot interferometer for displaying the intensity as a function of air pressure.

535.81 : 535.33.07

STRAY-LIGHT MEASUREMENTS ON A ZEISS SPECTROPHOTOMETER. See Abstr. 1259

535.822.1

1353. TOPOGRAPHIC MICROSCOPE. R.L.Saur.
Rev. sci. Instrum., Vol. 29, No. 11, 1023-6 (Nov., 1958).

Microscopic topography of matte and mirror surfaces can be measured visually. A straight-line reticle perpendicular to the plane of incidence is optically projected obliquely onto the surface. The image deviates laterally in response to vertical surface deviation. A microscope equipped with a filar eyepiece is used to measure the image deviation from a straight line. A simple formula based on the geometry of the optics is used to calculate the topographic deviation. Precision on surface grooves of 0.0005-0.005 in. deep is about ±6%. Sensitivity is about 0.00003 in. The method is absolute, quick, easy, and usable on nonflat surfaces.

535.822.17

1354. TWENTY YEARS OF PHASE-CONTRAST MICROSCOPY. H.Haselmann.
Z. wiss. Mikr., Vol. 63, No. 3, 140-55 (Jan., 1957). In German.

A review article which sketches the history of phase-contrast microscopy, its present status and the problems which still need to be solved. A list of 40 references is given. R.W.Fish

535.89 : 621.325.22

1355. A SELF-STRIKING CARBON ARC LAMP OF CONSTANT INTENSITY FOR MICROSCOPY. R.Gersing.
Z. wiss. Mikr., Vol. 63, No. 5, 257-60 (June, 1957). In German.

The carbons are driven through a differential gear by two servo-motors controlled by the arc current and voltage respectively, so giving a constant power input to the arc. W.T.Welford

# HEAT

536.2

1356. A FORM OF HEAT EQUATION WHICH ELIMINATES THE PARADOX OF INSTANTANEOUS PROPAGATION. C.Cattaneo.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 431-3 (July 28, 1958). In French.

Vernotte (Abstr. 6900/1958) eliminated the paradox of instantaneous propagation by changing the character of the classical equation of heat from parabolic to hyperbolic. The author points out that in a paper published in Atti del Seminario matematico e fisico della Universita di Modena, Vol. 3, 3-21 (1948) he obtained the same result, but derived it from considerations of kinetic theory. He gives an outline of his previous derivation. S.Weintroub

536.2

1357. TWO-DIMENSIONAL PERIODIC FLOW OF HEAT IN POLAR COORDINATES. H.Reismann.
J. Franklin Inst., Vol. 266, No. 4, 293-300 (1956).

Develops a technique for solving two-dimensional problems of periodic heat flow in polar coordinates. The form of series solution presented permits satisfaction of very general boundary conditions specified as surface temperature distributions which are periodic with respect to time. The method is applied to the solution of the radially symmetric plane problem of heat flow in an infinite region, exterior to a circular boundary, to which a uniformly distributed temperature is applied which varies periodically with respect to time.

536.212

1358. THERMAL CONDUCTIVITY OF SELENIUM AT LOW TEMPERATURES. G.K.White, S.B.Woods and M.T.Elford.
Phys. Rev., Vol. 112, No. 1, 111-13 (Oct. 1, 1958).

Measurements are reported of the thermal conductivity of glassy selenium and polycrystalline metallic (hexagonal) selenium at temperatures from 2° to above 100°K. At the higher temperatures, the

heat conductivity, λ, for the glassy solid is about 1 MW/(cm deg). If one writes $\lambda \approx \frac{1}{3}$ lCv, then l, the mean free path, is of the order of the interatomic distance. On the other hand, for the high-purity metallic samples, $\lambda \cong 5/T$ W/(cm deg). At low temperatures in metallic selenium, λ varies approximately as $T^2$, while in the glassy modification λ behaves in a similar fashion to that expected from earlier observations on soft glass and Pyrex.

536.212.2 : 621.785

1359. TEMPERATURE DISTRIBUTION THROUGHOUT A STACK OF ELECTRICAL SHEET STEEL DURING ANNEALING. R.J.Wakelin.
Brit. J. appl. Phys., Vol. 9, No. 9, 353-8 (Sept., 1958).

During the final annealing process in the manufacture of 4% silicon–iron electrical sheet, the temperature at any one time varies horizontally across the plane of the sheets and vertically up the stack. The temperature distribution in the horizontal plane of sheets 8 ft × 3 ft × 0.014 in. thick was calculated theoretically and compared with that determined experimentally. By combining the results from a number of experiments, the temperature distribution throughout a stack of sheets was obtained at all times during the three-day annealing cycle.

536.212.2 : 536.632 : 537.312.62

1360. INVESTIGATION OF THE THERMAL PROPERTIES OF SUPERCONDUCTORS. II. N.V.Zavaritskiĭ.
Zh. eksper. teor. Fiz., Vol. 34, No. 5, 1116-24 (1958). In Russian.

For Pt I, see Abstr. 3923/1958. The specific heat (c), thermal (K) and temperature conductivity ($a^2 = K/c\rho$, where ρ is the density) of aluminium and zinc were measured between 1.5 and 0.15°K by the temperature-wave method developed previously (see Pt I). Results of measurement of the normal-state specific heat are identical with those obtained at higher temperatures. The thermal conductivity of electrons in a superconductor depends exponentially on $T_c/T$. In this case the ratio of the thermal conductivity due to electrons and of the electronic specific heat, both for the superconducting state $K_{es}/c_{es}$, in contrast to electrons of normal metals, depends on temperature. The results obtained are compared with the results of measurement of the specific heat of other superconductors and with the results of the microscopic theory of superconductivity.

536.212.3 : 537.311.33

1361. THERMAL CONDUCTIVITY OF GERMANIUM. E.O.Devyatkova and I.A.Smirnov.
Zh. tekh. Fiz., Vol. 27, No. 9, 1944-9 (1957). In Russian.

The thermal conductivity of eight specimens of p- and n-germanium was measured in the temperature range 80-300°K. Below 200°K, the thermal conductivity of specimens of the same type depends upon the concentration of current carriers, which may be associated with scattering at impurity atoms. Specimens of p-germanium had a higher thermal conductivity than specimens of n-germanium throughout the experimental temperature range. It is concluded from the results that single crystals of p- and n-germanium have different microstructures.

536.212.3 : 537.311.32

THERMAL RESISTIVITY OF RUTHENIUM AND OSMIUM. See Abstr. 287

536.22

1362. THERMAL CONDUCTIVITY OF LIQUID OZONE. T.E.Waterman, D.P.Kirsh and R.I.Brabets.
J. chem. Phys., Vol. 29, No. 4, 905-8 (Oct., 1958).

The conductivity was determined experimentally. A value of $5.31 \times 10^{-4}$ cal/(sec)(cm²)(deg C/cm) at −183°C is reported. This value and values measured at three other temperatures are compared with published data for the thermal conductivity of liquid oxygen.

536.22

1363. STATISTICAL MECHANICAL THEORY OF THE THERMAL CONDUCTIVITY OF BINARY LIQUID SOLUTIONS. R.J.Bearman.
J. chem. Phys., Vol. 29, No. 6, 1278-86 (Dec., 1958).

A statistical mechanical theory of the thermal conductivity of solutions results from a generalization to the space of molecular pairs of the linear expressions appropriate to the thermodynamics of irreversible processes for the mean forces in singlet configuration space. When simplifying assumptions of the equilibrium regular solution theory are introduced into the general expression, the thermal conductivity of the mixture is obtained in terms of the thermal conductivities of the pure components, the self-diffusion coefficients, mole fractions, and molar volumes. Numerical calculations are in semiquantitative agreement with experiment.

536.223

1364. THERMAL CONDUCTIVITY OF GRAPHITE–SILICONE OIL AND GRAPHITE–WATER SUSPENSIONS. T.B.Jefferson, O.W.Witzell and W.L.Sibbitt.
Industr. engng Chem., Vol. 50, No. 10, 1589-92 (Oct., 1958).

Analytical relations for the conductivity of a two-component, two-phase mixture, determined by considering the fluid–solid suspension as divided into cubes, are applied to graphite–oil and graphite–(gelled) water suspensions. The conductivities of the former at six different concentrations of solid (0-59.4% by weight) and of the latter at four concentrations (0-48.7%) were measured. Comparison of the theoretical and experimental curves indicates that the analytical method is capable of predicting conductivities of the right order of magnitude. W.Good

536.23

1365. THERMAL CONDUCTIVITY OF MULTICOMPONENT GAS MIXTURES. C.Muckenfuss and C.F.Curtiss.
J. chem. Phys., Vol. 29, No. 6, 1273-7 (Dec., 1958).

An equation is derived for the complete second approximation to the thermal conductivity of multicomponent gas mixtures. The result is found to be identical with an "approximate" formula for the thermal conductivity derived on the assumption that the thermal diffusion coefficients are negligibly small.

536.23

1366. HEAT TRANSFER IN THE RAREFIED GASES. K.Takao and T.Fujimoto.
Mem. Fac. Engng Nagoya Univ., Vol. 9, No. 2, 379-89 (Nov., 1957).

The problem of the temperature distribution between two parallel plates is treated by a method based on the Maxwell–Boltzmann equation, which has been used in the dynamics of slightly non-uniform rarefied gases. S.Weintroub

536.23

1367. THE THERMAL CONDUCTIVITY OF CARBON DIOXIDE IN THE REGION OF THE CRITICAL POINT. L.A.Guildner.
Proc. Nat. Acad. Sci. U.S.A., Vol. 44, No. 11, 1149-53 (Nov., 1958).

The thermal conductivity in the density range near the critical density of 0.474 g/cm³ was shown to exhibit marked increases as the temperature of the critical point was approached from higher temperatures. The isotherms of thermal conductivity versus density are nearly symmetrical about the critical density, although some additional increase is observed on the low-density side. The rate of increase of thermal conductivity with diminishing temperature at constant density, $-(\partial K/\partial T)_\rho$, suggests an extremely high, if not infinite, value of the conductivity at the critical point itself. At temperatures higher than 40 deg. C above the critical temperature, the shape of the isotherm is nearly "normal", and at low and high densities the isotherms near the critical temperature behave in a normal fashion also.

536.23

1368. APPROXIMATE FORMULA FOR THE THERMAL CONDUCTIVITY OF GAS MIXTURES. E.A.Mason and S.C.Saxena.
Phys. of Fluids, Vol. 1, No. 5, 361-9 (Sept.-Oct., 1958).

An approximate formula for multicomponent gas mixtures is derived from rigorous kinetic theory by well-defined approximations. Numerical calculations with the formula are relatively simple, and the only data needed are the molecular weights, thermal conductivities, and either viscosities or heat capacities of the pure components at the same temperature as the mixture. The form of the formula is quite similar to the earlier empirical Lindsay–Bromley equation. The formula is tested by comparison with experimental results on a number of binary and ternary mixtures involving both monatomic and polyatomic nonpolar gases. Agreement is satisfactory, and is nearly as good as that obtained with the full rigorous theory.

536.23 : 533.72

THE STRESS TENSOR, DIFFUSION AND HEAT FLOW IN DENSE INHOMOGENEOUS GASES. See Abstr. 1172

536.253

1369. ON THE FREE CONVECTION FROM A HORIZONTAL PLATE. K.Stewartson.
Z. angew. Math. Phys., Vol. 9a, No. 3, 276-82 (Sept., 1958).

A theoretical study of the convection of heat, which takes place in boundary layers, from a heated horizontal plate. If the plate is heated and faces downward, or is cooled and faces upwards, a solution of the appropriate equations can be found which agrees moderately well with experiment. For the heated plate facing upwards, or the cooled plate facing downwards, the boundary layer problem is

not properly posed. It is shown that

$$N_{\mu} = 0.841\ (Ra)^{1/5},$$

where $N_{\mu}$ and Ra are the Nusselt and Rayleigh numbers, respectively. S.Weintroub

536.3.08

1370. PERFORMANCE CHARACTERISTICS OF A NEW LOW-TEMPERATURE BOLOMETER. W.S.Boyle and K.F.Rodgers, Jr.
J. Opt. Soc. Amer., Vol. 49, No. 1, 66-9 (Jan., 1959).

An infrared bolometer detector designed to operate at liquid helium temperatures was constructed by using the core of a carbon composition resistor as the sensitive element, making use of the well-known fact that the temperature coefficient of resistance of certain commercial carbon resistors is extremely large at low temperatures. Since the specific heat at these temperatures is small, it has proved to be relatively simple to construct a detector with a time constant of the order of milliseconds and a signal to noise figure surpassing any other known thermal detector of radiation. Furthermore, the resistivity of the material is such that most of the radiation striking the surface is absorbed even at frequencies in the far infrared. A brief discussion of the noise to be expected under nonequilibrium conditions is given. In practice it is found that current noise is about an order of magnitude larger than all other sources of noise.

536.33.08 : 536.23.08

1371. THE EFFICIENCY OF THE BISMUTH BOLOMETER. G.Wichert.
Exper. Tech. der Phys., Vol. 1, No. 4-5, 197-9 (Nov.-Dec., 1953). In German.

The efficiency of the bolometers described in an earlier paper (Abstr. 8301/1953) can be raised by decreasing the heat capacity by decreasing the pressure. C.Turner

536.413.2 : 537.311.31 : 538.222

THERMAL EXPANSION OF Ce–Th ALLOY. See Abstr. 455

536.413.2 : 539.2

NEGATIVE VOLUME EXPANSION COEFFICIENTS. See Abstr. 778

536.413.3 : 539.2

USE OF THERMAL EXPANSION MEASUREMENTS TO DETECT LATTICE VACANCIES. See Abstr. 803

536.42 : 534.222.2

1372. PHASE CHANGES OCCURRING IN WATER WHEN COMPRESSED BY STRONG SHOCK WAVES.
L.V.Al'tshuler, A.A.Bakanova and R.F.Trunin.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 1, 67-9 (1958). In Russian.

The range of pressure in experiments was 20 000-800 000 atm; the kinematic parameters of the shock wave (velocity of its propagation, and the mass velocity of the substance behind the front of the wave) were measured, using the modification suggested by one of the authors (Abstr. 7478, 7573/1958), in which the shock wave reaches the substance tested through a screen made from a material for which the Hugoniot adiabat of the shock wave is known. A phase transition was found to occur at a shock-wave pressure of about 115 000 atm. F.Lachman

536.423.4

1373. AN EXPERIMENTAL STUDY OF THE CONDENSATION OF WATER VAPOUR ON THE SURFACE OF CERTAIN ORGANIC SUBSTANCES. A.Brin.
J. Rech. Cent. Nat. Rech. Sci., No. 35, 149-68 (June, 1956). In French.

By means of a simple condensation chamber the part played by molecular structure on the formation of centres of condensation is determined. Irradiation by ultraviolet light favours the formation of these centres. On non-wetting substances, such as paraffin wax, water vapour is not condensed unless it is supersaturated at the temperature of the surface. The experiments are described in detail and the results discussed. H.C.Cole

536.423.4

1374. CONDENSATION PRODUCED BY ULTRA-VIOLET LIGHT. A.J.Barnard and W.L.Mouton.
Nature (London), Vol. 182, 1001-2 (Oct. 11, 1958).

The exposure of a damp gas in a cloud chamber to ultraviolet light may result in a marked increase in the condensation on expansion, but the origin of the condensation nuclei is obscure. Initial experiments performed with various gas–vapour mixtures in a conventional rubber-diaphragm chamber indicated that the nuclei did not arise from the gas but from contamination from the chamber materials. This conclusion was confirmed by experiments using a special chamber, which is illustrated and described, and which was operated with water as condensant. S.Weintroub

536.424 : 539.89

1375. TEMPERATURE DEPENDENCE OF THE PHASE TRANSITION IN CERIUM. R.Herman and C.A.Swenson.
J. chem. Phys., Vol. 29, No. 2, 398-400 (Aug., 1958).

The cubic-condensed cubic transition in cerium was observed as a function of temperature and pressure from 360°K and 11 000 atm to 78°K and zero pressure. The data which were obtained definitely link the high pressure, room temperature and the low temperature, zero pressure transitions which were observed previously. While the data show some unexplained features, the calculated value for the latent heat of transition at 288°K (1150 ± 100 cal/mole) agrees as to order of magnitude with a directly measured value (880 ± 40 cal/mole) by other workers.

536.424.1

1376. THEORY OF PHASE TRANSFORMATIONS IN ALKALI METALS. M.A.E.Nutkins.
Proc. Phys. Soc., Vol. 72, Pt 5, 810-22 (Nov., 1958).

A theory is suggested to account for the phase changes which have been observed by Barret et al. (Abstr. 3351/1947; American Mineralogist, Vol. 33, 749, 1948; Abstr. 792/1957; Transactions of the American Institute of Mining (and Metallurgical) Engineers, Vol. 175, 579, 1948) in lithium and sodium. The elastic constants for the face-centred and body-centred cubic structures were calculated and from them the free energies determined. An interesting conclusion is that the electrostatic and ionic terms alone are not sufficient to account for the phase change. The Fermi energy of the conduction electrons is affected by shear, and hence this part of the total energy gives rise to a contribution to the elastic shear constants. The difference in this contribution between the two cubic structures was found to be adequate to account for the observed phase change. An estimation of the transition temperature indicated that it lies in the range 40°-100°K.

536.46 : 539.18

1377. CYCLOTRON RESONANCE IN FLAMES.
J.Schneider and F.W.Hofmann.
Phys. Rev. Letters, Vol. 1, No. 11, 408-9 (Dec. 1, 1958).

This resonance could be observed in acetylene–oxygen flames containing some alkali salt provided that the collision time was greater than the radiofrequency period. Absorptions were observed at 24 000 Mc/s when the pressure was reduced to below 100 mm Hg. Both the collision time and the electron density could be derived from the resonance curve and the simplified classical theory. D.Walsh

536.46 : 534.222.2

INTERACTION OF SHOCK WAVES WITH A COMBUSTION ZONE. See Abstr. 1194

536.48

1378. BOSE–EINSTEIN CONDENSATION IN LIQUID HELIUM. O.Penrose.
Nuovo Cimento Suppl., Vol. 9, No. 1, 256-61 (1958).

The concept of Bose–Einstein condensation is formulated in such a way that it can be applied to assemblages of interacting particles. Criteria for the occurrence of this condensation are formulated and it is shown that liquid helium complies with the criteria. Relations between Bose–Einstein condensation and Landau's theory of helium are established. R.Eisenschitz

536.48

1379. BOSE–EINSTEIN CONDENSATION AND THE λ-TRANSITION IN LIQUID HELIUM. M.S.Green.
Phys. Rev. Letters, Vol. 1, No. 11, 409-11 (Dec. 1, 1958).

Elaborating an (unpublished) method of Yang and Lee the author obtains an expression for the grand partition function of an assembly of interacting bosons. By discussing the partition function, difficulties are found in assigning to the Bose–Einstein condensation a transition of an order lower than the 3rd. This, however, seems to be in contradiction to experiment. R.Eisenschitz

536.48

1380. COEFFICIENT OF THERMAL EXPANSION OF LIQUID $He^3$ NEAR 0°K. K.A.Brueckner and K.R.Atkins.
Phys. Rev. Letters, Vol. 1, No. 9, 315-16 (Nov. 1, 1958).

Recent calculations by Brueckner and Gammel (Abstr. 2278/1958) on the properties of liquid $He^3$ near 0°K are applied to the coefficient

of thermal expansion $\alpha$. It is found that $\alpha$ is negative: $\alpha = -0.076\ T$ for $T < 0.2^\circ K$. The effect is due to the increase of the effective mass with decreasing volume. H.London

536.48

1381. LENGTH EFFECT IN THE HEAT TRANSPORT IN HELIUM II. H.Forstat.
Phys. Rev., Vol. 111, No. 6, 1450-2 (Sept. 15, 1958).

A length effect in the heat transport in helium II in small channels was observed. Measurements were made using a column of packed jeweller's rouge for lengths of 3.179, 5.166, and 8.156 cm in the temperature range 1.70-2.17°K. The channel size was approximately 0.1 micron. The results verified the linear dependence of the heat current density on temperature difference and showed a decrease in the heat transport by approximately a factor of 2 as the rouge length was increased from 3.179 to 8.156 cm.

536.48

1382. SECOND SOUND IN $^3$He–$^4$He MIXTURES. H.A.Fairbank.
Nuovo Cimento Suppl., Vol. 9, No. 1, 325-33 (1958).

The author gives an account of his own measurements (pulse method) and considers alternative experimental data and results of the theory. The effective mass of $He^3$, the dependence of the $\lambda$-point on the concentration, and the 2 phase equilibrium in mixtures of high concentration, are discussed. It is shown that the present results are not sufficient to decide whether the phase richer in $He^3$ has the property of superfluidity. R.Eisenschitz

536.48 : 534.22

VELOCITY OF SOUND IN LIQUID HELIUM. See Abstr. 1192

536.48 : 534.22

VELOCITY OF SOUND IN A $He^3$–$He^4$ MIXTURE. See Abstr. 1193

536.5.081 : 536.421.4

1383. THE FREEZING POINTS OF HIGH PURITY METALS AS PRECISION TEMPERATURE STANDARDS. IV. INDIUM: THERMAL ANALYSES ON THREE GRADES OF CADMIUM. E.H.McLaren.
Canad. J. Phys., Vol. 36, No. 9, 1131-47 (Sept., 1958).

For Pt III, see Abstr. 5846 (1958). An investigation of the freezing and melting temperatures of a sample of high purity indium (Cominco 99.999 + %) was made. Plateaux of essentially constant ($< \pm 0.0001^\circ C$) temperature with durations for over 1 hour are readily obtained on the cooling curves of induced freezes on this metal. The standard deviation of the plateau temperature (liquidus point) from a series of 24 induced freezes was $\pm 0.0001^\circ C$. The pressure effect on the freezing temperature of indium was found to be $0.0049^\circ C$ for 1 atm. Alloy-melting ranges were measured following different types of freezing. An extensive intercomparison of liquidus points and alloy melting ranges was made on a sample of 99.99% cadmium and two samples of 99.999+ % cadmium from different suppliers. The liquidus points of the high-purity samples were indistinguishable using precision resistance thermometry but one sample melted over a slightly smaller range of temperature than the other. Both these samples showed minor arrests on melting curves after induced freezing and detailed analyses of the melting contours after various types of freezing indicated some evidence of characteristic structure inside a range of $0.002^\circ C$.

536.52

1384. TRUE TEMPERATURE CALIBRATION OF A RIBBON FILAMENT TUNGSTEN LAMP. M.L.Lemmens.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 44, No. 5, 483-92 (1958). In French.

Describes a spectrographic method of finding the true temperature of a ribbon filament W lamp by comparison with a full radiator (black body). The lamp is operated at various currents giving different true temperatures up to 2600°K, and comparisons with the full radiator at a number of different wavelengths give accordant results. The values used for the emissivity of W are those of de Vos (Abstr. 1656/1954). J.W.T.Walsh

536.521 : 535.81

1385. LIGHT GUIDE RADIATION PYROMETRY.
J.Vollmer, G.C.Rein and J.A.Duke.
J. Opt. Soc. Amer., Vol. 49, No. 1, 75-7 (Jan., 1959).

A method of calculating and describing transmission characteristics of light guides is developed and applied to rods of synthetic sapphire. The total transmission is shown to be an inadequate measure of the extent to which a calibration curve relating relative signal to temperature is possible for a light guide radiation pyrometer. The angular field of view of synthetic sapphire rod is presented in terms of fractional emergent power per five degree angular increment. It is concluded that the transmission properties presented here, in combination with data for a single point, permit the simple, individual calibration of commercially available light guide radiation pyrometers.

536.521 : 535.81

1386. MORE ACCURATE ADJUSTMENT OF FILAMENT PYROMETERS BY MEANS OF CONTRASTING PLATES. J.Euler.
Optik, Vol. 15, No. 6, 372-81 (June, 1958). In German.

An increase of accuracy from ±0.4% to ±0.1% was obtained by dividing the field of vision in two or more areas of different brightness of object or of filament. Glass plates of different refractivity, or polarization filters, can be used for dividing the field of vision. F.Lachman

536.531 : 621.317.39

1387. HYPODERMIC NEEDLE THERMISTOR RESISTANCE THERMOMETER FOR THE MEASUREMENT OF VERY SMALL TEMPERATURE DIFFERENCES IN THE HUMAN BODY. F.Eiber.
Z. angew. Phys., Vol. 10, No. 8, 379-82 (Aug., 1958). In German.

The thermistor is less than 0.3 mm in diameter and the hypodermic needle approximately 0.7 mm. Full details of the necessary Wheatstone bridge circuit are given and the relative bridge, galvanometer and thermometer characteristics are considered in relation to the sensitivity obtainable. Using a galvanometer having a constant of $3.3 \times 10^{-9}$ A/mm, the sensitivity is about $2 \times 10^{-4}$ deg C. E.H.Dock

536.58

1388. A METHOD OF MAINTAINING TEMPERATURE CONTROL OVER A WIDE RANGE. H.L.Allsopp and D.F.Gibbs.
J. sci. Instrum., Vol. 35, No. 11, 395-7 (Nov., 1958).

It is sometimes desirable to control the temperature in an apparatus without having to use a bath of stirred liquid as a means of maintaining thermal equilibrium. The apparatus described is applicable to such cases, thermal equilibrium being maintained by a stream of gas that is brought to the required temperature in a heat exchanger. The system is effective in the range from $-150^\circ$ to $200^\circ C$, and the temperature stability varies from about $\pm 1^\circ C$ in the range from $20^\circ$ to $200^\circ C$, to $\pm 5^\circ C$ below $-110^\circ C$.

536.62 : 539.16

1389. CALIBRATION OF A CALORIMETER: A MINOR PEACEFUL USE FOR PLUTONIUM. [Lord] Rothschild.
Nature (London), Vol. 182, 789-90 (Sept. 20, 1958).

A modified Clarke-Rothschild calorimeter of volume 2.4 ml was calibrated using plutonium oxide needles. The use of these is shown to be of advantage as compared with radium needles. E.W.Kellermann

536.631

1390. ATOMIC HEAT OF DIAMOND FROM 11° TO 200°K.
D.L.Burk and S.A.Friedberg.
Phys. Rev., Vol. 111, No. 5, 1275-82 (Sept. 1, 1958).

The atomic heat of 8.3 moles of clear diamond chips was measured between 11° and 200°K in a vacuum calorimeter. The capsule correction was made a much smaller fraction of the total heat capacity in this work than in earlier investigations, resulting in improved accuracy at the lowest temperatures. Comparison is made with the theoretical values of Marcus. The observations are consistent with the calculated $\theta$ variation and with a $\theta_D(0) = 2240^\circ \pm 5^\circ K$ calculated from the elastic constants. Small discrepancies with the theory at the lowest temperatures are attributed to causes other than the vibrational heat capacity of the bulk lattice.

536.631.07

1391. $He^3$ CRYOSTAT FOR MEASURING SPECIFIC HEAT.
G.Seidel and P.H.Keesom.
Rev. sci. Instrum., Vol. 29, No. 7, 606-11 (July, 1958).

An apparatus employing a bath of liquid $He^3$ as a coolant was developed for measuring specific heats below 1°K. Temperatures as low as 0.30°K can be maintained for long periods of time. A description of a simple thermal switch is also included.

# THERMODYNAMICS

536.7 : 532.77

1392. THE THERMODYNAMIC PROPERTIES OF THE SYSTEMS: $HNO_3$–$H_2O$ AND $HNO_3$–$N_2O_4$. A.Potier.
Ann. Fac. Sci. Univ. Toulouse, Vol. 20, 1-98 (1956; publ. 1957). In French.

An account of careful measurements which give the volume and partial pressures and (hence) the thermodynamic mixing properties of the liquid solutions $HNO_3$–$H_2O$ ($0^\circ$C-$20^\circ$C) and $HNO_3$–$N_2O_4$ ($-10^\circ$C, $0^\circ$C-$10^\circ$C). Some qualitative conclusions are drawn (e.g. concerning the dimerization of $N_2O_4$) but there is no serious theoretical discussion. R.O.Davies

536.7

1393. THERMODYNAMICS FOR NONISOTHERMAL SYSTEMS. THE CLASSICAL FORMULATION. J.C.M.Li.
J. chem. Phys., Vol. 29, No. 4, 747-54 (Oct., 1958).

The classical theory of Thomson, Eastman, and Wagner of the thermodynamics of nonisothermal systems is studied in the light of the Gibbs' formulation of heterogeneous equilibrium. It is found that an extension of Gibbs' derivation will include the classical theory of nonisothermal equilibrium as a special case. The Onsager reciprocal relations can be obtained from macroscopic considerations which also give a relation between the second-order phenomenological coefficients. The concept of second-order independence is introduced, which provides a way of finding the actual processes.

536.71

1394. HEAT OF FORMATION OF $BaC_2$. M.Hoch.
J. appl. Phys., Vol. 29, No. 11, 1588-9 (Nov., 1958).

Determined by measuring the Ba pressure above $BaC_2$ + C using the Knudsen effusion method. The heat of formation of $BaC_2$ from the elements is $\Delta Hf^\circ_{298} = -12.1 \pm 4$ kcal/M.

536.717

1395. A DIAGRAM OF STATE FOR SUPERHEATED STEAM. J.F.Ury.
Appl. sci. Res, A, Vol. 6, No. 2-3, 141-6 (1956).

It is shown that for a wide range of conditions the properties of superheated steam satisfy the equation $pV = RT$, where R is very nearly a function only of the entropy S. A graph of R as a function of S is given. P.T.Landsberg

536.75 : 534.222.2

ENTROPY CHANGE DURING RELAXATION OF A GAS BEHIND A SHOCK WAVE. See Abstr. 1197

536.782

1396. THE JOULE–THOMSON EFFECT AND ITS MEASUREMENT. W.Koeppe.
Exper. Tech. der. Phys., Vol. 4, No. 6, 278-85 (1956). In German.

Methods for measuring the Joule–Thomson effect are reviewed, and the various constructions proposed by Hausen, Dalton, Zelmanov, Burnett and Roebuck, and Eucken for the nozzle, through which the compressed gas expands, are briefly described. The isothermal nozzle effect and its measurement is then shortly discussed. There are 32 references and 7 diagrams. H.H.Hodgson

536.79 : 532.61

1397. SOME THERMODYNAMIC FORMULAE AND THEIR INTERPRETATION. H.Köhler.
Ark. Geofys., Vol. 2, Paper 21, 453-70 (1956).

A detailed discussion of certain fundamental thermodynamic relations involving surface tension phenomena.

P.T.Landsberg

# ELECTRICITY

# ELECTROSTATICS. DIELECTRICS

537.212 : 621.365

1398. ELECTRIC FIELDS IN ENCLOSED SURROUNDINGS, RESULTING FROM STARTING UP OF OVENS WITH BARE METALLIC WIRES. S.Gandolfo.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 4, 329-36 (1955-56). In Italian.

In experiments performed in a steel framed building, a bare nichrome wire was heated to incandescence by alternating current at 160 V, 50 c/s. An electric field was observed around the wire, persisting for times up to about 30 min after switching off the current. The potential increased with the area of the wire. The electrometer was frequently checked and found not to be giving any spurious readings. No theoretical explanation is offered.

N.Corcoran

537.213

1399. AN AXIALLY SYMMETRIC ELECTROSTATIC PROBLEM FOR A CONDUCTOR IN THE FORM OF A SEMI-INFINITE TUBE WITH THIN WALLS. N.N.Lebedev and I.P.Skal'skaya.
Zh. tekh. Fiz., Vol. 28, No. 4, 792-800 (1958). In Russian.

An exact solution is given for the problem of the potential distribution in the vicinity of a thin semi-infinite cylinder (tube), placed in any axially symmetrical external field. A new method is developed for solving a category of static problems, analogous to corresponding methods used for the study of a similar category of boundary problems of diffraction theory encountered in connection with the study of acoustic and electromagnetic waves from the open end of cylindrical and plane waveguides. As an example of the application of the method, a solution is given for the problem of the distribution of the field of a point charge situated on the axis of a thin, semi-infinite tube.

537.22

1400. DEMONSTRATION EXPERIMENTS IN ELECTROSTATICS. D.S.Ainslie.
Amer. J. Phys., Vol. 26, No. 8, 549-51 (Nov., 1958).

Outlines methods of producing positive electrification, for demonstrations in electrostatics, and modifications in the standard electrophorus suitable for use in humid weather. A short description is given of construction and action of an electrostatic machine with cylindrical elements and the use of a radiotron circuit to demonstrate the importance of shielding sensitive electrical equipment.

537.221

1401. $CO_2$ ELECTROSTATIC GENERATOR. S.Mascarenhas, F.Gambirasio and Y.Mascarenhas.
Amer. J. Phys., Vol. 26, No. 8, 563-6 (Nov., 1958).

Several interesting electrical effects observed with solid and gaseous CO are reported. An electrostatic generator running at $-78^\circ$C with dry ice is described. The generator, which can be easily constructed, is capable of giving a 8 $\mu$A short-circuit current and enough voltage (from 15 to 20 kV) for the performance of all common electrostatic demonstrations. Quantitative data about the generator are also given. A discussion of the basic charge-separating mechanism is given, supported by a series of simple experiments. These results indicate that charge separation takes place in the nozzle of the gas cylinder, probably owing to friction of the escaping gas with the walls.

537.221

1402. THE MECHANISM OF ELECTROSTATIC CHARGING. I.M.Imyanitov.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 1, 93-6 (1958). In Russian.

An explanation is given of the effect of accumulation of charge on relatively large bodies moving in a medium consisting of small bodies, e.g. aeroplanes in flight. Z.Krasucki

537.221

1403. DISSIPATION OF ELECTROSTATIC CHARGES WITH A STREAM OF IONIZED AIR. F.Běhounek.
Naturwissenschaften, Vol. 44, No. 12, 347-8 (1957). In German.

A current of air was passed through an ion counter to which a radioactive source is connected. The number of ions per millilitre decreases with increasing speed of the air current, whereas the number of ion pairs per second increases to a value corresponding to about 0.7 e.s.u./sec for a $\beta$-ray activity of 500 $\mu$c.

R.Schnurmann

537.222 : 537.311.33

1404. SOLUTIONS FOR THE STATIC JUNCTION. L.Gold.
J. Electronics and Control, Vol. 5, No. 5, 427-31 (Nov., 1958).

The characteristic non-linear differential equation which arises from Poisson's relation for the static distribution of charge is analysed for its solutions when either rather loose or restrictive boundary conditions prevail. While the former admits a number of closed form solutions, an inverse series solution, appropriate particularly for diverse impurity distributions in the p–n junction, is developed for the spatial variation of the electrostatic potential.

537.224

1405. THE ELECTROSTATIC FIELD AT THE EDGE OF A PLANE CAPACITOR WITH A DIELECTRIC SPACER. N.N.Lebedev.
Zh. tekh. Fiz., Vol. 28, No. 6, 1330-9 (1958). In Russian.

The theoretical basis and numerical calculations are given for the case of a capacitor which contains a spacer whose permittivity is different from the permittivity of the bulk of the dielectric.

537.226 : 621.315.61

1406. ELECTRICAL DISPERSION PHENOMENA IN INHOMOGENEOUS DIELECTRICS. R.Parker and M.S.Smith.
J. Electronics and Control, Vol. 5, No. 4, 354-61 (Oct., 1958).

The theory of Koops (see Abstr. 6964/1951) of electrical dispersion in materials with high resistivity surface layers is extended to a model which incorporates an arbitrary distribution of layer thicknesses and layer orientations. It is found that this generalized model gives rise to precisely the same dispersion equations which have been formulated by Koops. Observed deviations from these equations are ascribed to inhomogeneities in the current density vector in these materials and experimental results are reported which strongly support this hypothesis. The importance of these considerations to the evaluation of surface layer parameters is discussed and a more plausible value for the thickness of surface layers is obtained.

537.226.08 : 621.317.371

1407. THE MEASUREMENT OF THE DIELECTRIC PROPERTIES OF LIQUIDS IN AN $H_{01}$ RESONATOR. J.S.Dryden.
J. sci. Instrum., Vol. 35, No. 12, 439-40 (Dec., 1958).

A simple container which has proved suitable for the measurement of the dielectric properties of liquids in an $H_{01}$ resonator is described, together with a method of correcting for the meniscus.

537.226.1

1408. THE APPLICATION OF ONSAGER'S THEORY TO DIELECTRIC DISPERSION. N.E.Hill.
Proc. Phys. Soc., Vol. 71, Pt 4, 532-6 (Oct., 1958).

It is shown that previous applications of Onsager's theory to dielectric dispersion have contained an incorrect assumption about the behaviour of the reaction field when the applied field is varying. An equation for the complex dielectric constant is derived, using Onsager's model and taking proper account of the reaction field. An approximate method of solving the equation is developed and it is shown that the equation approximates closely to the simple Debye equation

$$\epsilon - \epsilon_\infty = (\epsilon_0 - \epsilon_\infty)/(1 + j\omega\tau)$$

the microscopic and macroscopic relaxation times being almost identical.

537.226.1

1409. THE PROBLEM OF EMERGENCE OF SPONTANEOUS POLARIZATION IN CRYSTALS. G.A.Smolenskiĭ.
Zh. tekh. Fiz., Vol. 27, No. 8, 1778-83 (1957). In Russian.

The criteria for occurrence of ferroelectricity are considered. The problem of ferroelectrically active ions and the nature of the chemical bonds in ferroelectrics and antiferroelectrics are discussed. Some experimental data on the structure of the electron shells of the ions in the oxygen octahedra in ferroelectrics not containing hydrogen are presented.

Electrical Research Association

537.226.2

1410. TABLES OF DIELECTRIC DISPERSION DATA FOR PURE LIQUIDS AND DILUTE SOLUTIONS. F.Buckley and A.A.Maryott.
Circ. Nat. Bur. Stand., No. 589, 95 pp. (Nov. 1, 1958).

Primary dielectric dispersion data and characteristic dispersion parameters are tabulated for almost 200 substances in the liquid state and for dilute aqueous and nonaqueous solutions with more than 150 solutes. There are six tables and one section of graphs. There are four tables for pure liquids, two containing summaries of the derived dispersion parameters and two containing the primary data. The section on graphs supplements the tables for pure liquids and contains reproductions of pertinent data that are available only in the form of graphs.

537.226.2 : 539.19

1411. DIELECTRIC PROPERTIES OF POLYPEPTIDE SOLUTIONS. I. THE ELECTRIC DIPOLE MOMENT OF $\alpha$ HELIX IN DIOXANE. A.Wada.
J. chem. Phys., Vol. 29, No. 3, 674-5 (Sept., 1958).

Measurements on poly-$\gamma$-benzyl-L-glutamate in dioxane show it to have a very large electric dipole moment. The static dielectric constants in several concentrations are tabulated and it is pointed out that this result is consistent with the $\alpha$-helix molecular configuration.

R.C.Glass

537.226.2

1412. MICROWAVE ABSORPTION AND MOLECULAR STRUCTURE IN LIQUIDS. XXIV. THE DIELECTRIC RELAXATION OF LIQUID AMMONIA. K.Fish, R.C.Miller and C.P.Smyth.
J. chem. Phys., Vol. 29, No. 4, 745-6 (Oct., 1958).

For previous work, see Abstr. 2162 (1957). Dielectric constant and loss measurements at wavelengths of 3.22 and 1.24 cm were carried out upon liquid ammonia at temperatures from $-55^\circ$ to $-35^\circ$C. The results are used to calculate the approximate dielectric relaxation time values, $1.5 \times 10^{-12}$ sec at $-50^\circ$ and $1.3 \times 10^{-12}$ at $-40^\circ$. The relaxation times and the liquid viscosities are much smaller than those of water, but extrapolation to the boiling points of the two liquids gives values of comparable magnitudes.

537.226.2

1413. STUDY OF VARIATION OF DIELECTRIC RELAXATION TIME WITH SOLVENT. C.R.K.Murty.
J. sci. industr. Res., Vol. 17B, No. 11, 441-4 (Nov., 1958).

Relaxation times of acetophenone, benzyl alcohol and aniline were determined in dilute solutions in four non-polar solvents, cyclohexane, benzene, carbon disulphide and n-hexane. The variation of relaxation time with solvent is discussed in the light of the new approaches made recently for modifying the Debye equation.

537.226.2

1414. MILLIMETER WAVE DISPERSION IN ETHYL CHLORIDE. Krishnaji and G.P.Srivastava.
Z. Phys., Vol. 152, No. 1, 116-22 (1958).

The dispersion in the range from 1.34 to 1.44 $cm^{-1}$ is computed by means of quantum mechanical formulae. It is found that dispersion is due to (1) contribution of six R-branch rotational lines in the region considered; (2) contribution of R-branch lines away from the region; and (3) the contribution of Q branch lines at zero wave number. The maximum variation in the susceptibility is $1.9 \times 10^{-6}$ and occurs at $\nu = 1.39$ $cm^{-1}$ due to combined contribution of transitions at 1.3878 $cm^{-1}$, 1.3902 $cm^{-1}$ and 1.3927 $cm^{-1}$.

537.226.2

1415. CONTRIBUTION TO THE PHENOMENOLOGICAL THEORY OF THE DIELECTRIC AFTER-EFFECT IN CERAMIC DIELECTRICS. A.Hersping and K.Blank.
Z. angew. Phys., Vol. 10, No. 8, 371-6 (Aug., 1958). In German.

Using the Clausius—Mosotti equation, the complex dielectric constant is transformed into a complex polarizability $p' - jp''$. The experimental results, which consist of permittivity and loss measurements on various rutile samples over a wide range of frequencies and temperatures, are then presented as plots of p' against p'' at constant temperatures. The plots can be fitted to circular arcs similar to Cole—Cole plots, and the various dispersion regions are traced through the temperature range, at the same time deriving their activation energies. No detailed explanation of the dispersion mechanism is attempted. The Maxwell—Wagner effect is re-examined from the viewpoint of p being the fundamental quantity.

K.W.Plessner

537.226.2 : 539.431

1416. DIELECTRIC AND MECHANICAL LOSSES OF LOW-PRESSURE POLYETHYLENE.
G.P.Mikhaĭlov, S.P.Kabin and T.A.Krylova.
Zh. tekh. Fiz., Vol. 27, No. 9, 2050-5 (1957). In Russian.

The experimental investigation of the dielectric and mechanical losses of low-pressure polyethylene revealed two ranges of maxima of tan $\delta$ in the frequency ranges 1.5 and 10 kc/s and in the temperature interval $-110$ to $+120^\circ$C. The two types of relaxation losses are due to h.f. and l.f. relaxation. The temperature relation of the mechanical losses was determined by the ultrasonic method at 2 Mc/s and was found to be of h.f. relaxation type.

Electrical Research Association

537.226.2

1417. ROOM-TEMPERATURE FERROELECTRICITY IN LITHIUM HYDRAZINIUM SULFATE, $Li(N_2H_5)SO_4$.
R.Pepinsky, K.Vedam, Y.Okaya and S.Hoshino.
Phys. Rev., Vol. 111, No. 6, 1467-8 (Sept. 15, 1958).

$Li(N_2H_5)SO_4$ is ferroelectric over the temperature range from below $-15^\circ$C to above $80^\circ$C, and shows no dielectric peaks between $-196^\circ$C and $140^\circ$C. No thermal anomalies are observed. The

crystals are orthorhombic, space group $Pbn2_1$, with a = $8.96_9$ A, b = $9.91_3$ A, c = $5.17_8$ A, and the ferroelectric axis is, of course, along c; $\rho$ = 1.966 g/cm$^3$, and there are 4 molecules per cell. The coercive field is about 320 volts/cm at room temperature, and the spontaneous polarization is 0.30 microcoulomb/cm$^2$. Large crystals can be grown from water by a variety of methods. After electroding, the crystal plates should be protected by silicone oil. Without such protection, reaction with normal atmosphere for prolonged time results in excessive conductivity.

537.226.2 : 536.424.1

1418. NON-FERROELECTRIC PHASE TRANSITIONS IN SOLID SOLUTIONS FORMED IN THE SYSTEMS (Ca,Sr)(Ti,Zr)$O_3$ AND Na(Nb,Ta)$O_3$.
G.A.Smolenskiĭ, V.A.Isupov, A.I.Agranovskaya and E.D.Sholokhova.
Zh. tekh. Fiz., Vol. 27, No. 11, 2528-34 (1957). In Russian.

The phase transitions in these systems are complicated, so that previous authors could not agree on the number of phases involved, cubic, tetragonal, almost-cubic, trigonal-rhombic and orthorhombic being mentioned. In particular, introduction of small quantities of potassium and sodium niobates is stated to convert the antiferroelectric transition at 360°C into a ferroelectric transition. The present authors found only ordinary crystallographic transitions and that neither calcium titanate nor the solid solutions are antiferroelectrics. Electrical Research Association

537.226.2

1419. DIELECTRIC POLARIZATION AND LOSSES OF CERTAIN COMPLEX COMPOUNDS. G.A.Smolenskiĭ and A.I.Agranovskaya.
Zh. tekh. Fiz., Vol. 28, No. 7, 1491-3 (1958). In Russian.

$Pb_3NiNb_2O_9$ (A) and $Pb_3MgNb_2O_9$ (B) were synthesized. Both possess perovskite structure; A is a ferroelectric ($\epsilon_{max.}$ ~ 12 000) with a Curie temperature of −10°C, B has high permittivity ($\epsilon_{max.}$ ~ 1000) due to a relaxation mechanism. The values of tan δ range up to 0.1.

537.226.2

1420. NEW FERROELECTRICS OF COMPLEX COMPOSITION. II. $Pb_2Fe^{3+}NbO_6$ and $Pb_2YbNbO_6$.
G.A.Smolenskiĭ, A.I.Agranovskaya, S.N.Popov and V.A.Isupov.
Zh. tekh. Fiz., Vol. 28, No. 10, 2152-3 (1958). In Russian.

$Pb_2Fe^{3+}NbO_6$ (C) and $Pb_2YbNbO_6$ (D) were synthesized by a solid-state reaction (firing) at 950°C and 900°C respectively. Both these compounds possess perovskite structure. C is a ferroelectric ($\epsilon_{max.}$ ~ 5000 at 112°C), D is an antiferroelectric ($\epsilon_{max.}$ ~ 400 at 280°C). The values of tan δ for C range up to 0.125 at 200°C.

537.226.2

1421. ON SOME ANOMALIES IN THE HYSTERESIS LOOP OF CERAMIC BARIUM TITANATE AND "PIEZOLAN". E.Hegenbarth.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 20-5 (1957). In German.

The constricted "propeller"-shaped hysteresis loops after ageing, and the double hysteresis loops just above the Curie point were observed with fine-grained barium titanate specimens. A further anomaly consisted of small steps in the loops in the region of increasing polarization. This is thought to be due to Barkhausen jumps. K.W.Plessner

537.226.2 : 534.232

1422. THE PREPARATION OF BARIUM TITANATE AS A CERAMIC TRANSDUCER MATERIAL. A.L.Gray and J.M.Herbert.
Acustica, Vol. 6, No. 2, 229-34 (1956).

Modified barium titanate ceramics can be prepared with reduced temperature coefficients at room temperature. Values of coercive field and dielectric loss which permit the operation of transducers up to the onset of cavitation in liquids can be obtained. The mechanical and electrical properties of the modified ceramics change significantly with time, but the drift can be minimized. Transducers of suitable shapes can be made by a variety of methods.

537.226.2

1423. INTERPRETATION OF ELECTRON PARAMAGNETIC RESONANCE IN $BaTiO_3$. A.W.Hornig, R.C.Rempel and H.E.Weaver.
Phys. Rev. Letters, Vol. 1, No. 8, 284-6 (Oct. 15, 1958).

Resonance spectra different from those of Low and Shaltiel (Abstr. 6945/1958) are reported and are interpreted as arising from impurity ferric ions at titanium sites. A critical discussion of the points of difference is presented. A.J.Manuel

537.226.2

1424. ELECTRON PARAMAGNETIC RESONANCE IN $BaTiO_3$.
W.Low and D.Shaltiel.
Phys. Rev. Letters, Vol. 1, No. 8, 286 (Oct. 15, 1958).

Further work has reduced the disagreement (Abstr. 6945/1958) with the results of Hornig, Jaynes and Weaver (Abstr. 2006/1955) and Hornig, Rempel and Weaver (preceding abstract). A.J.Manuel

537.226.2 : 537.533.8

INTERACTION OF LOW-ENERGY ELECTRONS WITH FERROELECTRIC MATERIALS. See Abstr. 345

537.226.2 : 539.27

SURFACE AND DOMAIN STRUCTURE IN CERAMIC BARIUM TITANATE. See Abstr. 866

537.226.32

1425. THE CHARGES ON ELECTRETS. K.Palm.
Exper. Tech. der Phys., Vol. 4, No. 6, 253-62 (1956). In German.

The surface charges which remain after cooling the samples in an electric field were measured for PVC, polymethylmethacrylate and polystyrene. Heterocharges were found with the two former materials, homocharges with the latter. Plots of charge density against time are shown for a number of polarizing field strengths. The effects are explained quantitatively in terms of frozen-in dipole orientation (heterocharge) and charge transfer from the electrodes (homocharge). K.W.Plessner

537.228.1

1426. PIEZO-EFFECT OF SELENIUM RECTIFIERS. T.Numata.
J. Phys. Soc. Japan, Vol. 13, No. 9, 1066 (Sept., 1958).

When an oscillating mechanical impulse is applied to a selenium rectifier, up to 10 mV a.c. can be developed across it. This may be due to a barrier piezo-electric effect. C.Hilsum

537.228.4

1427. DISPERSION OF THE ELECTRO-OPTIC KERR EFFECT IN THE INFRARED REGION. E.Charney and R.S.Halford.
J. chem. Phys., Vol. 29, No. 1, 221-8 (July, 1958).

The infrared dispersion of electro-optic anisotropy was investigated theoretically and experimentally. Anomalies of the refractive index in the neighbourhood of resonant absorptions are accompanied by anomalous dispersion in the electro-optic Kerr effect. A theoretical analysis of the effect of molecular structure on the form of the anomalous behaviour demonstrates that the relative orientation of the permanent molecular dipole and the radiation-induced dipole determines the sign of the deviation of the dispersive behaviour from normal. The dependence on the applied electrostatic field strength is predicted to be the same in resonant and nonresonant regions. Experimental examination of the electro-optic anisotropy of nitrobenzene at field strengths of 28 000 V/cm to 48 000 V/cm in the overtone region (1.5-5.6 μ) of the infrared spectrum confirms these theoretical conclusions.

537.228.4 : 535.55

PHOTOELECTRIC ARRANGEMENT FOR THE MEASUREMENT OF THE KERR EFFECT. See Abstr. 1347

# ELECTRIC CONDUCTION SEMICONDUCTORS

537.311.1

1428. A GENERALIZED VARIATIONAL PRINCIPLE FOR TRANSPORT PHENOMENA. G.E.Tauber.
Canad. J. Phys., Vol. 36, No. 10, 1308-18 (Oct., 1958).

A generalized variational principle is formulated which takes the phonon distribution functions and the external magnetic field into account, is valid for an arbitrary direction of the electric field and polarization of the lattice vibrations, and does not depend on any special form of the energy surfaces. The various transport coefficients, for both thermoelectric and thermomagnetic phenomena, are obtained by the Ritz method in terms of infinite determinants without requiring an explicit solution of the transport equations.

537.311.31

1429. SOME ASPECTS OF THE BEHAVIOUR OF ELECTRICAL RESISTIVITY AFTER PLASTIC DEFORMATION. [Enkele aspecten van het gedrag van de electrische weerstand na plastische deformatie]. C.W.Berghout.

Delft Dissertation (1956) 114 pp. In Dutch (3pp summary in English).

Experimental results on the electrical resistivity of Cu after cold working are given. The extra resistivity due to cold working is divided into two equal parts. One is removed by annealing at low temperatures and is not correlated with any recovery of yield strength. The other is correlated with yield strength. Results on the recovery of the resistivity of cold-worked zirconium and on the validity of Matthiessen's rule are also given. The results are discussed on the basis of dislocation and lattice defect theory.

M.R.Hopkins

537.311.31 : 539.2

1430. RESISTIVITY DUE TO DISLOCATIONS IN COPPER.
W.A.Harrison.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 44-6 (1958).

The scattering of electrons by a dislocation with a hollow core is treated. It is found that the effect of such a core upon the electrical resistivity may be many times greater than the effect of the strain field. If the change in volume of the crystal due to dislocations is set equal to the core volume (of the order of one atomic volume per interatomic distance of dislocation), a rough calculation indicates that the change in resistivity for 1% change in volume is about one-half of that observed in annealing experiments on cold-worked copper. It is suggested that the general magnitude of the interaction between conduction electrons and the core may be correct, even if the specific hollow-core model is not valid. Hence it appears that a consideration of the scattering by the core provides order-of-magnitude agreement with experiment for the resistivity due to dislocations.

537.311.31 : 538.221

1431. MAGNETIC SUSCEPTIBILITY OF SOME URANIUM ALLOYS. RESISTANCE PROPERTIES OF SOME URANIUM ALLOYS.
L.F.Bates and R.G.Loasby.
Proc. Phys. Soc., Vol. 72, Pt 5, 757-64 (Nov., 1958).

The magnetic susceptibilities and electrical properties of a series of quenched alloys of uranium with zirconium, niobium and molybdenum, metals which have four, five and six outer electrons respectively, were measured over the temperature range 90 to 300° K. The general features of the three systems are the same, with anomalies at about 0.5 and 2.0 atomic per cent of the solute. The first anomaly is of unknown origin, and the second suggests that alloys containing up to about 2 atomic per cent of the solute may be obtained in the $\alpha$-form by quenching them from the $\gamma$-phase field, and that within this composition range the behaviour is consistent with the full Brillouin zone structure that has been proposed for $\alpha$-uranium.

537.311.31 : 536.413.2 : 538.222

TEMPERATURE DEPENDENCE OF THE RESISTIVITY OF SOME Ce–Th ALLOYS. See Abstr. 455.

537.311.31 : 538.222 : 539.219

RESISTIVITY OF $\gamma$-URANIUM ALLOYS. See Abstr. 858

537.311.32 : 537.312.5

1432. ON THE ELECTRICAL CONDUCTIVITY OF SOLID ORGANIC INSULATORS. N.Riehl.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 93-128 (1957). In German.

Measurements above room temperature on naphthalene, anthracene, paraffin and polystyrene showed that the electrical conductivity was proportional to $\exp(-B/T)$, where T is the absolute temperature and B = 0.7, 0.75, 0.55, 0.4 eV, respectively. The electrical conductivity increased (but not B) for higher electrical fields in the range $10^5$–$10^6$ V/cm. Subsidiary experiments established that the conduction was due to the parent substance and not due to impurities. Qualitative arguments are advanced to explain the low values of B and of the magnitude and variation of the electrical conductivity (typically around $10^{-16}$ ohm$^{-1}$ cm$^{-1}$) which involve highly efficient monomolecular recombinations of the thermally produced ions. Observations of a reversible breakdown and of photoconduction are also reported.

R.Stratton

537.311.32

1433. DETERMINATION OF THE ELECTRONIC CONDUCTIVITY IN SILVER HALIDES BY MEANS OF POLARIZATION MEASUREMENTS. B.Ilschner.
J. chem. Phys., Vol. 28, No. 6, 1109-12 (June, 1958).

The current passing through a cell, silver/silver halide/graphite, was measured as a function of applied potential in the temperature range between 200 and 370°C, for potentials less than 0.5 V. Under these conditions, the current for steady-state conditions is mainly electronic. Definite results were obtained for AgBr and AgI, but not for AgCl because of sluggish approach to steady-state conditions. From an analysis of the current–potential curves it is concluded that excess electron conduction prevails in AgBr, but hole conduction in AgI.

537.311.33

1434. SIMPLE METHODS OF INVESTIGATION OF THE BAND STRUCTURE OF SOME SEMICONDUCTOR COMPOUNDS.
V.E.Khartsiev.
Zh. tekh. Fiz., Vol. 27, No. 8, 1713-22 (1957). In Russian.

The author works out general expressions for determining the band structure in semiconductors. A general, one-dimensional problem is first studied and its solution is used in the analysis of a three-dimensional-network model for compounds with the Zn-blende structure and for semiconductors with NaCl-type structure.

Metallurgical Abstracts

537.311.33

1435. THEORY OF THE EFFECT OF A MAGNETIC FIELD ON THE ABSORPTION EDGE IN SEMICONDUCTORS.
R.J.Elliott, T.P.McLean and G.G.Macfarlane.
Proc. Phys. Soc., Vol. 72, Pt 4, 553-65 (Oct., 1958).

A magnetic field splits up electron energy bands in a solid into a series of sub-bands. The absorption edge which arises from transitions between two such bands across an energy gap then shows a structure from transitions between the various sub-bands. The shape of this structure is considered for direct transitions between simple spherical bands, spheroidal bands and degenerate bands. This often takes the form of a series of peaks from which the effective masses of the bands can be determined, but there are cases in which the effect of the field is less dramatic and forms a series of steps. Absorption from indirect transitions involving phonons also forms a series of steps.

537.311.33

1436. SPACE CHARGE CALCULATIONS FOR SEMICONDUCTORS.
R.Seiwatz and M.Green.
J. appl. Phys., Vol. 29, No. 7, 1034-40 (July, 1958).

The electric field at the surface of a semiconductor is obtained as a function of the semiconductor bulk properties and the potential difference across the space charge region. The treatment is general enough to take into account degenerate free carrier distributions and partial ionization of impurities, either in the neutral bulk or the space charge region, or both. A one-dimensional model with a spatially homogeneous impurity distribution is assumed. The density of states in the conduction and valence bands is assumed to be that appropriate for spherical and ellipsoidal energy surfaces. The common model for simple donor and acceptor states is used. Conditions under which the equation for the field can be conveniently simplified are discussed, and a particular case is treated numerically. The validity of the free carrier distribution functions in the high fields near the semiconductor surface is discussed, and the equation for the electric field at the semiconductor surface, where the bulk impurities are described by a general model, given.

537.311.33

1437. CALCULATIONS ON THE SHAPE AND EXTENT OF SPACE CHARGE REGIONS IN SEMICONDUCTOR SURFACES.
G.C.Dousmanis and R.C.Duncan, Jr.
J. appl. Phys., Vol. 29, No. 12, 1627-9 (Dec., 1958).

The shape and extent of space charge regions in semiconductor surfaces are briefly discussed. Curves describing the potential as a function of distance inside the semiconductor are obtained by numerical integration of the Poisson equation. The curves apply to all semiconductors. They show the effects of different resistivities and the increased depth of the space charge regions expected in pure III-V compounds over those encountered in Ge and Si.

537.311.33

1438. THE ENERGY SPECTRUM OF CURRENT CARRIERS IN SEMICONDUCTORS OF THE GERMANIUM TYPE.
A.G.Samoĭlovich and K.D.Tovstyuk.
Zh. tekh. Fiz., Vol. 27, No. 8, 1753-63 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1629-38 (Aug., 1957).

The paper proposes a model that accounts for the nature of the chemical bond when the energy spectrum in semiconductors of the germanium type is studied. An analysis is made of the energy spectrum of current carriers in germanium and silicon. It is established that the special features of the energy spectrum of holes are caused not by spin–orbital interaction but by the distribution of clouds of valence electrons at the bonds (i.e. essentially by the

nature of the chemical bond). It is shown that an electron energy spectrum that agrees with experimental data can be found by an appropriate choice of wave-functions.

537.311.33 : 538.632

1439. HALL MOBILITY OF CARRIERS IN IMPURE NONDEGENERATE SEMICONDUCTORS. M.S.Sodha and P.C.Eastman.
Phys. Rev., Vol. 112, No. 1, 44 (Oct. 1, 1958).

The discussion takes into account scattering by lattice vibrations, ionized impurities, and neutral impurities. The study is confined to the case of low temperatures and high impurity concentrations, for which Sclar's theory (Abstr. 3257/1957) of ionized impurity scattering is valid.

537.311.33 : 621.382

1440. ON THE LIFETIME AND DIFFUSION CONSTANT OF THE INJECTED CARRIERS AND THE EMITTER EFFICIENCY OF A JUNCTION TRANSISTOR. S.Deb and A.N.Daw.
J. Electronics and Control, Vol. 5, No. 6, 514-30 (Dec., 1958).

Values of the effective lifetime and the apparent diffusion constant of minority carriers in the base region of p–n–p alloy junction transistors of three different types have been determined. It is found that for a given temperature the effective lifetime passes through a maximum as the bias current is increased from a low value. This is explained on the basis of the relative contributions to the lifetime of volume and surface recombination. The analysis also yields separately values of the volume and the surface recombination lifetimes. Both lifetimes are found to decrease with decreasing temperature. Further, volume recombination lifetime is found to be appreciably smaller than that observed in n-type germanium in bulk. The true values of the diffusion constants, as determined from measured apparent values, are found to obey an empirical relation that closely agrees with the relation for bulk germanium semiconductor of the same type. A method of estimating emitter efficiency based on a critical analysis of the observed apparent values of the diffusion constant in the light of the theoretical relation given by Webster (Abstr. 3535B/1954, Proc. Inst. Radio Engrs, Vol. 42, 914-20, June, 1954) is also suggested. It is found that for the transistors under investigation estimated values of emitter efficiency remain closely equal to unity under the usual operating conditions.

537.311.33 : 621.315.59 : 621.317.619

1441. MEASUREMENT OF LIFETIME BY THE PHOTOCONDUCTIVE DECAY METHOD. B.K.Ridley.
J. Electronics and Control, Vol. 5, No. 6, 549-58 (Dec., 1958).

General equations have been derived for the decay of photo-injected carriers in a semiconductor with time by taking as the solution of the continuity equation an eigen series whose parameters are determined by the usual boundary condition at the surface and also by the condition that the series correctly describes the carrier distribution an instant before decay begins. Both steady-state and pulsed initial distributions are considered, and it is shown that the decay is exponentail only for zero surface recombination. With high surface recombination velocities the loss of exponential nature of the decay leads to an error in the measured value of filament lifetime. This error has been found numerically and graphically for various lifetimes and penetration depths. With white light the error is estimated to be not more than 5% for the steady state method and not more than 10% for the pulsed state method, these extreme values occurring at lifetimes of about 1 $\mu$sec.

537.311.33 : 538.63

1442. THEORY OF GALVANOMAGNETIC EFFECT AT HIGH MAGNETIC FIELD. R.Kubo, H.Hasegawa and N.Hashitsume.
Phys. Rev. Letters, Vol. 1, No. 8, 279-81 (Oct. 15, 1958).

Preliminary calculations are presented, based on an expression for the conductivity tensor in terms of time dependent, quantum mechanical, current operators. This avoids the (doubtful) use of Boltzmann's equation in the high field range when the cyclotron frequency exceeds the inverse relaxation time for electron scattering.

R.Stratton

537.311.33

1443. REMARKS ON THE LOW-TEMPERATURE ANOMALIES IN THE IMPURITY SEMICONDUCTORS. I-II. M.I.Klinger
Zh. tekh. Fiz., Vol. 27, No. 8, 1915-19, 1919-22 (1957). In Russian.

Fritzsche and Lark-Horovitz (Abstr. 7955/1955), who investigated the low-temperature properties of p-type single crystals of InSb found that at low temperature, T, and under strong magnetic field, H, the variation of resistivity $\Delta\rho = \rho_H - \rho_0$ becomes negative and $\Delta\rho/\rho_H$ increases with increasing H/T. Since this effect cannot be explained by ordinary theory of semiconductivity, the present author attempts to explain the observed anomalies on the basis of his theory of the galvanomagnetic phenomena (Abstr. 3270/1957).

Metallurgical Abstracts

537.311.33 : 621.315.59

1444. THE EFFECT OF STRAIN ON THE THERMOELECTRIC PROPERTIES OF A MANY-VALLEY SEMICONDUCTOR.
J.R.Drabble.
J. Electronics and Control, Vol. 5, No. 4, 362-72 (Oct., 1958).

The electrical conductivity and thermoelectric power of a many-valley semiconductor are considered as functions of strain, neglecting all effects other than those due to carrier transfer between valleys. For non-degenerate materials, a general treatment is given and it is shown that the absence of other effects can be checked by the condition that the trace of the conductivity tensor is unaltered by the strain. Under these conditions the conductivity and thermoelectric power tensors can be combined to give an expression, valid for any strain, which according to the theory, involves only the relative shifts in the minimum energies of the valleys. By measuring these for different strains it is possible in principle to obtain the complete deformation potential tensor for a given material. An estimate of the order of magnitude shows that the effects should be readily measurable in n-type germanium.

537.311.33

1445. ELECTRICAL PROPERTIES OF $Ag_2Se$. S.Miyatani.
J. Phys. Soc. Japan, Vol. 13, No. 3, 317 (March, 1958).

Reports experimental data for Hall constant, thermoelectric power, and the Nernst coefficient, in the temperature range from 150° to 300°C.

C.A.Hogarth

537.311.33 : 538.63

1446. ELECTRIC AND MAGNETIC PROPERTIES OF THIN FILMS OF ANTIMONY.
A.Colombani, C.Vautier and P.Huet.
C.R. Acad. Sci. (Paris), Vol. 247, No. 21, 1838-41 (Nov. 24, 1958). In French.

The effects of thickness on resistivity and of magnetic field and thickness on the Hall constant and magnetoresistance are described. These properties are independent of thickness when it exceeds 900 A. The results agree well with Sondheimer's theory of the effect of the mean free path of electrons on the conductivity of thin films (Abstr. 3578/1952 and 6610/1956).

R.C.Kell

537.311.33 : 537.323

1447. THE ELECTRICAL PROPERTIES OF BISMUTH ALLOYS. III. TERNARY ALLOYS. "REVERSION" TO THE PROPERTIES OF BISMUTH. L.I.Mokievskiĭ and G.A.Ivanov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1695-706 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1576-86 (Aug., 1957).

The paper investigates the electrical properties (electrical conductivity, Hall effect, thermo-e.m.f. and magnetoresistance) of the alloys Bi–Te–Sn, Be–Te–Pb, Bi–Sn–Se and Bi–Pb–Se. Relationships are obtained between the components of alloys consisting of elements of the IV and VI Groups of the periodic table, which yield a "reversion" of the alloys to properties which are the same as those of pure Bi. The concentration of the current carriers and their mobilities are computed in Bi and in ternary "reverted" alloys.

537.311.33

1448. ELECTRICAL PROPERTIES OF BISMUTH SELENIDES, $Bi_2Se_3$ AND BiSe. I. RESISTIVITY AND HALL EFFECT.
K.Hashimoto.
Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 4, 141-50 (Jan., 1958).

Measurements are reported on the resistivity and Hall effect of $Bi_2Se_3$ and BiSe. For single crystals of $Bi_2Se_3$, two maxima of the Hall coefficient $R_\perp$ and the resistivity $\rho_\perp$ are found at the same temperatures, that is, room temperature and about 10°K. The resistivity $\rho_\parallel$ shows a maximum value at room temperature and a minimum at about 100°K and tends to become constant at temperatures below 20°K. The anisotropies of the Hall coefficient $R_\parallel/R_\perp$ and of the resistivity $\rho_\parallel/\rho_\perp$ are 0.76 and 5.5, respectively, at room temperature. For the polycrystals of $Bi_2Se_3$, the band gap $E_g$ is about 0.2 eV and the activation energy of the donor state $E_d$ 0.003 eV. The long wavelength absorption edge of $Bi_2Se_3$ is found to be about 0.2 eV. For the polycrystals of BiSe, the band gap $E_g$ is about 0.4 eV.

537.311.33 : 538.632

1449. THE ELECTRICAL PROPERTIES OF BISMUTH TELLURIDE. R.Mansfield and W.Williams.
Proc. Phys. Soc., Vol. 72, Pt 5, 733-41 (Nov., 1958).

Measurements of the electrical conductivity, Hall coefficient, thermoelectric power and Nernst coefficient on specimens cut from zone-melted $Bi_2Te_3$ and on a single crystal are described. The current flow was parallel to the cleavage planes and the galvanomagnetic effects of the single crystal were measured with the magnetic field perpendicular and parallel to the cleavage planes. For the other specimens the Hall and Nernst coefficients were measured with the magnetic field perpendicular to the cleavage planes. The temperature range was 100°K to 600°K and specimens with a wide variation of impurity content were used. Analysis of the thermoelectric power and conductivity in the extrinsic range indicated that the specimens were partially degenerate, and when allowance is made for this, the temperature dependence of mobility is $T^{-1.63}$ for electrons and $T^{-1.94}$ for holes. In the high temperature range the conductivity measurements yield a value of the energy gap at 0°K of 0.21 eV. The temperature dependence of the Hall coefficient in the extrinsic range is anomalous and the explanation is not known. The Nernst coefficient Q exhibits the general behaviour expected for a semiconductor, and it is shown that it obeys a relation which can be derived from Moreau's relation, Q being proportional to $TR\sigma(d^2E/dT^2)$ (thermoelectric power = $dE/dT$, Hall coefficient = R, conductivity = $\sigma$).

537.311.33 : 538.63

1450. MAGNETO-RESISTANCE EFFECT IN CADMIUM SULPHIDE. S.Tanaka and T.Masumi.
J. Phys. Soc. Japan, Vol. 13, No. 3, 314 (March, 1958).

Experiments on single crystals show that the relative change in resistivity is a linear function of $H^2$ below 8000 Oe, and that there are oscillations in the values of relative resistance as the angle between the current and the magnetic field or between the field and crystal axes are varied. C.A.Hogarth

537.311.33

1451. SPACE-CHARGE LIMITED CURRENTS IN INSULATING MATERIALS. G.T.Wright.
Nature (London), Vol. 182, 1296-7 (Nov. 8, 1958).

Measurements were made of the steady current—voltage characteristic of a thin cadmium sulphide crystal, with an indium cathode and graphite anode. In the forward direction, the current remains zero up to 2.5 V, increases rapidly up to 5.7 V, and then increases proportionally to the square of the applied voltage, in the manner predicted theoretically for a space-charge limited current. In the reverse direction, the current is negligible. The possibilities of using these properties for fundamental studies and for new solid-state devices are briefly discussed. J.B.Birks

537.311.33

1452. THE SEMICONDUCTING BEHAVIOUR OF GALLIUM TELLURIDE ($Ga_2Te_3$). G.Harbeke and G.Lautz.
Z. Naturforsch., Vol. 11a, No. 12, 1015-17 (1956). In German.

From the temperature dependence of the electrical conductivity and the u.v. optical absorption curve, values of 1.55 eV and 1.22 eV, respectively, were deduced for the forbidden energy gap. A possible connection between anomalies of the conductivity—temperature curves above 670°C and a phase transition from the zincblende to the wurtztite lattice is discussed. R.Stratton

537.311.33 : 538.63

1453. MAGNETORESISTANCE IN N-TYPE GERMANIUM AT LOW TEMPERATURES. R.A.Laff and H.Y.Fan.
Phys. Rev., Vol. 112, No. 2, 317-21 (Oct. 15, 1958).

Magnetoresistance was studied for n-type single-crystal germanium of $4 \times 10^{15}$ effective donors/cm$^3$. The effective anisotropy parameter K was found to decrease from ~20 at 300°K to ~6 at 20°K. Values close to 20 were again obtained at 7°K and 4.2°K. By introduction of compensating acceptors with heat treatment, it was shown directly that the decrease of K was due to anisotropic scattering by ionized impurities, and the anisotropy was investigated by using different degrees of compensation. Below 7°K, the scattering is determined by neutral impurities, and the high value of K indicates that the scattering is isotropic.

537.311.33

1454. AMBIPOLAR TRANSPORT OF CARRIER DENSITY FLUCTUATIONS IN GERMANIUM. J.E.Hill and K.M. van Vliet.
Physica, Vol. 24, No. 9, 709-20 (Sept., 1958).

The spectrum of generation—recombination noise in semiconductors may differ from the usual form at relatively high field strengths or relatively short drift times of the carriers. In contrast to previous opinions it is shown that such a modification occurs only if the ambipolar drift velocity is sufficiently large. Accordingly, the sweeping of carriers through the sample by the electric field has no effect in material with a single type of carrier or in intrinsic material, but should show up in near-intrinsic crystals. Measurements, made to detect this effect, completely confirmed this behaviour. From the "resonances" in the spectra the ambipolar drift time was determined and found to be in good agreement with the calculated values.

537.311.33

1455. OBSERVATION BY CYCLOTRON RESONANCE OF THE EFFECT OF STRAIN ON GERMANIUM AND SILICON. A.C.Rose-Innes.
Proc. Phys. Soc., Vol. 72, Pt 4, 514-22 (Oct., 1958).

Cyclotron resonance at microwave frequencies is used to observe the changes in the band structure of germanium and silicon caused by a non-isotropic elastic strain. It is shown that an elongation of the crystal in a given direction raises the energy of those minima of the conduction band which lie on the corresponding direction in momentum space and, conversely, a contraction lowers the energy. A non-isotropic strain decreases the intensities of the hole resonances but this effect has not been studied in detail. The results are consistent with conclusions drawn from piezoresistance measurements.

537.311.33 : 535.345

1456. INFRARED ABSORPTION OF PHOTOGENERATED FREE CARRIERS IN GERMANIUM. L.Huldt and T.Staflin.
Phys. Rev. Letters, Vol. 1, No. 7, 236-7 (Oct. 1, 1958).

Shows the spectral dependence of the increase in absorption coefficient due to optical generation of carriers. When the carriers are generated by radiation absorbed near to one surface, a study of the increase as a function of distance from this surface gives the hole diffusion length. C.Hilsum

537.311.33

1457. INFLUENCE OF ELEMENTS OF THE III AND IV GROUPS ON THE RATE OF RECOMBINATION OF ELECTRONS AND HOLES IN GERMANIUM. V.G.Alekseeva, S.G.Kalashnikov, L.P.Kalnach, I.B.Karpova and A.I.Morozov.
Zh. tekh. Fiz., Vol. 27, No. 9, 1931-9 (1957). In Russian.

The influence of bismuth, antimony, thallium and gallium on the rate of recombination of electrons and holes in germanium was investigated. It was found that alloying with bismuth and thallium greatly accelerates recombination, whilst antimony and gallium are much less active. A connection is indicated between the effective recombination centres, produced by the various elements and the values of their distribution coefficients (atomic radii).

537.311.33 : 539.21

LOW-TEMPERATURE IRRADIATION OF N-TYPE GERMANIUM. See Abstr. 826

537.311.33

1458. ELECTRICAL CONDUCTIVITY IN P-TYPE InSb UNDER STRONG ELECTRIC FIELD. Y.Kanai.
J. Phys. Soc. Japan, Vol. 13, No. 9, 1065-6 (Sept., 1958).

A departure from Ohm's Law at fields of 20 V/cm is said to be due to very light holes with a mobility ten times that of electrons. At 60 V/cm, the Hall coefficient changes sign. C.Hilsum

537.311.33 : 539.2

INDIRECT TRANSITIONS AT THE CENTRE OF THE BRILLOUIN ZONE WITH APPLICATION TO InSb. See Abstr. 774

537.311.33

1459. $FeSe_2$, A SEMICONDUCTOR CONTAINING IRON. G.Fischer.
Canad. J. Phys., Vol. 36, No. 10, 1435-8 (Oct., 1958).

Measurements of the conductivity and Hall coefficient were made on three samples, two stoichiometric and one iron-rich (rather porous), in the temperature range 77°K to 500°K. From the slope of the conductivity curve the forbidden energy gap was estimated to be 0.3 ± 0.1 eV. Further experiments indicate that $FeS_2$ is probably nonmagnetic. R.Stratton

537.311.33 : 537.323

1460. ELECTRICAL PROPERTIES OF THE LEAD—ANTIMONY SYSTEM. I.D.Konozenko and V.I.Ust'yanov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1686-94 (1957). In Russian.

Alloys containing 11, 12, 13, 14 and 37 wt.%, i.e. up to 50 at.% Sb

were investigated. Spectrographically pure Sb and Pb with < 0.001% Sn and Cu were used for the preparation of the experimental samples melted in evacuated glass ampoules. The electrical conductivity of all the studied alloys and their thermo-e.m.f. against Cu were measured at 0°-300°C. The Hall effect and the sign and concentration of the current carriers were determined at room temperature only, with the exception of the 50 at.% Sb alloy in which the temperature dependence of the Hall effect was studied at 0°-300°C. The experimental results are shown in the form of graphs and are correlated with the constitution of Pb–Sb alloys. Metallurgical Abstracts

537.311.33

1461. ELECTRICAL PROPERTIES OF MERCURY TELLURIDE. R.O.Carlson.
Phys. Rev., Vol. 111, No. 2, 476-8 (July 15, 1958).

Polycrystalline HgTe, as prepared in sealed quartz tubes, was found to be p-type with acceptor concentrations of $10^{18}$–$10^{19}$ $cm^{-3}$ and band gap ~0.02 eV. Diffusion of zinc and copper into samples indicates that the former is a donor impurity, the latter an acceptor impurity. Measurements of resistivity and Hall effect extended to liquid hydrogen temperature reveal a marked magneto-Hall effect. The Hall coefficient changes sign at temperatures as low as 20°K. Some measurements of thermoelectric power and thermal conductivity are also given.

537.311.33 : 621.315.59

1462. THE EFFECT OF HEAT TREATMENT ON THE BREAKDOWN CHARACTERISTICS OF SILICON PN JUNCTIONS. A.R.Plummer.
J. Electronics and Control, Vol. 5, No. 5, 405-16 (Nov., 1958).

Silicon p–n junctions have been studied which exhibit soft breakdown in the reverse characteristic, and experiments are described which show that this can be caused not only by surface conditions, but also by unsuitable bulk properties resulting from heat treatment of the silicon. An explanation for this effect is suggested.

537.311.33

1463. PREPARATION OF PURE SILICON BY THERMAL DECOMPOSITION OF SILANE.
S.I.Kleshchevnikova, Ya.E.Pokrovskiĭ and E.I.Rumyantseva.
Zh. tekh. Fiz., Vol. 27, No. 8, 1645-8 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1529-32 (Aug., 1957).

A description is given of a method and apparatus for preparation of pure silicon by thermal decomposition of monosilane. Monosilane is prepared by disproportionation of triethoxysilane in presence of metallic sodium, and after very simple purification it is directly subjected to thermal decomposition. The decomposition occurs on a tantalum band heated electrically to 950°. The crust of polycrystalline silicon formed can be separated from the tantalum in the form of a rod, suitable for zone recrystallization. The single crystals obtained by crucibleless zone fusion of the silicon rods have specific resistances of up to 50 ohm cm, with nonequilibrium electron lifetimes of up to 300 microseconds.

537.311.33 : 621.383.5

1464. ON THE MODE OF ACTION OF N–P–N PHOTOTRANSISTORS. A.Hoffmann.
Z. angew. Phys., Vol. 10, No. 9, 416-18 (Sept., 1958). In German.

A plausible explanation of the mechanism can be given by considering the element as two parts: a normal transistor and a photodiode in parallel with the collector-base region. It is shown that the arrangement with the photo-diode in the emitter-base region does not give true amplification of the photocurrent. This conclusion is confirmed experimentally. K.W.Plessner

537.311.33 : 621.382

1465. ON P–N JUNCTION IN SOLID POINT-CONTACT RECTIFIERS. V.G.Mel'nik, I.G.Mel'nik and S.S.Gutin.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 5, 852-4 (1958). In Russian.

The thermo-e.m.f. and current–voltage characteristics of n-type Ge and Si point-contact rectifiers before and after electroforming were studied on experimental models in which thin metallic threads had been welded on to the point-contact wires. The threads were heated by electric current to 500-600°C and the thermal front thus produced moved along the contact wires to the Ge and Si crystals. An inversion of sign of the thermo-e.m.f. observed after electroforming both in Ge and Si was taken to indicate passage of the thermal front from a region of p-type conductivity to one characterized by n-type conductivity, and it was concluded that while the rectifying action of point-contact diodes before electroforming is due to different contact potentials of the metal and semiconductor, the improved rectifying characteristics after electroforming are due to the existence of a p–n junction formed as the result of the electroforming treatment. M.H.Sloboda

537.311.33 : 539.219

DISSOLUTION OF GERMANIUM BY INDIUM IN SEMICONDUCTOR DEVICES. See Abstr. 861

537.311.33 : 548.574

SELECTIVE ELECTROLYTIC ETCHING OF GERMANIUM AND SILICON JUNCTION TRANSISTOR STRUCTURES. See Abstr. 923

537.312.5 : 537.311.33

1466. ON KINETICS OF PHOTODIODES. S.M.Rŷvkin.
Zh. tekh. Fiz., Vol. 27, No. 8, 1676-85 (1957). In Russian.

The effect of the operating conditions of Ge photodiodes on the relaxation processes is qualitatively discussed. Two systems of operating the diode are considered, the "photodiode" system, when back-voltage is applied, and the "valve" system, characterized by high internal resistance of the circuit. An explanation is given of the causes of the different character of the relaxation curves characteristic for these two " systems", and the anomalous behaviour of the diodes operating under the "photodiode" system. Metallurgical Abstracts

537.312.5 : 537.311.33

1467. THE INFLUENCE OF SURFACE TREATMENT OF SEMICONDUCTORS ON THE MAGNITUDE AND SPECTRAL DISTRIBUTION OF PHOTOCONDUCTIVITY.
S.M.Rŷvkin and R.Yu.Khansevarov.
Zh. tekh. Fiz., Vol. 28, No. 5, 925-31 (1958). In Russian.

Additional evidence is now presented in confirmation of the very pronounced effect of some forms of surface treatment of specimens of CdS and $Cu_2O$. The surface treatment consisted in intense electronic bombardment, heating in vacuum and in air and a short-period stay in a gas discharge.

537.312.5

1468. ON THE SPECTRAL RESPONSE OF PHOTOCONDUCTION IN THIN SINGLE CRYSTALS OF ANTHRACENE.
J. Ferguson and W.G. Schneider.
Canad. J. Chem., Vol. 36, No. 12, 1633-9 (Dec., 1958).

The photoconduction of thin crystals of anthracene (sublimation flakes) was studied as a function of the wavelength of the incident light as well as the geometry of the "surface cell" arrangement. With spot electrodes on one face of the crystal, the spectral response showed a very pronounced difference depending on whether the electrode face or the opposite face was illuminated. In the latter case the spectral response followed the absorption curve of the crystal, whereas when the electrode face was illuminated the photoconductivity was a minimum at wavelengths corresponding to maximum extinction coefficients of the crystal.

537.312.5

1469. EVIDENCE FOR THE TRIPLET STATE IN PHOTOCONDUCTIVITY IN ANTHRACENE. B.Rosenberg.
J. chem. Phys., Vol. 29, No. 5, 1108-18 (Nov., 1958).

Some evidence is presented indicating that the formation of a triplet state is involved as an intermediary step in the creation and transfer of charges in the photoconduction process in organic substances. On the basis of the simple potential curve picture, approximate solutions are obtained to the rate process equations. These equations predict that the density of the triplet states under thermal and optical equilibrium conditions will follow a Boltzmann exponential dependence upon temperature with an energy equal to a low multiple (1 or 2) of the vibrational spacing of the excited singlet state. The assumption is made that the photocurrent is proportional to the triplet state density. Measurements by the author and others of the photoconduction activation energy in a number of aromatic hydrocarbons are in very good agreement with this. The triplet state model also requires that the buildup and decay of the photocurrents be approximately monomolecular with time constants at low temperatures and intensities equivalent to the lifetime of the triplet state. The experimental results corroborate this. The model also suggests that direct absorption into the triplet state should cause photoconduction. The experimental results with anthracene are not conclusive on this point. The model of photoconduction in organic material is predicated on a molecular rather than an extended band model approach. The major contribution to the photocurrent comes from molecules which have undergone a spin conversion while in the excited state to the triplet state of the molecule. The long lifetime of this metastable state and the assumed partial localization of the

uncoupled electrons increases the probability of an intermolecular quantum tunnelling of the positive hole in the ground state orbital.

537.312.5

1470. PHOTOCONDUCTIVITY IN CADMIUM SELENIDE. [Fotogeleiding in cadmium-selenide]. H.J.Dirksen. University of Delft Dissertation (1958), 98 pp. In Dutch with abstract (2 pp.) in English.

Pure and doped monocrystals of CdSe and thin evaporated layers were prepared, and measurements made of the photocurrent as a function of wavelength and intensity of the incident light and of the temperature of the material. The behaviour of CdSe is described by an E–B diagram, in which discrete levels are represented by points, the E and B coordinates of which are measures of the electron occupation in thermal equilibrium and under illumination, respectively. The redistribution of electrons under illumination at various temperatures is obtained from the position of the points on the diagram. There are two regions in which the change in distribution is very pronounced – the inversion regions; the characteristic photoconductivity of CdSe is ascribed to discrete levels in these regions. From measurements of the excitation rate, the redistribution of electrons among the different discrete energy levels was obtained. Deviations from the characteristic behaviour are accounted for by the introduction into the E–B diagram of a level, which corresponds to volume acceptors, surface states and surface charges.

J.Franks

537.312.5

1471. SOME ASPECTS OF PHOTOCONDUCTIVITY IN CADMIUM SELENIDE CRYSTALS. R.H.Bube and L.A.Barton. J. chem. Phys., Vol. 29, No. 1, 128-37 (July, 1958).

Vacuum annealing of insulating and insensitive cadmium selenide crystals grown from the vapour phase increases their photosensitivity to a value at least as high as that of crystals sensitized by impurity incorporation. Such annealing-sensitized crystals have one hundred to one thousand times greater sensitivity than impurity-sensitized crystals at low light intensities and/or high operating temperatures. A new infrared quenching band with maximum at 1.0 eV is found at elevated temperatures, correlated with the residual sensitivity of the annealing-sensitized crystals. The same sensitizing centres are involved in the photoconductivity of annealing-sensitized and impurity-sensitized cadmium selenide crystals, regardless of whether the excitation is absorbed only at the surface or throughout the volume. In annealing-sensitized crystals, the effective volume for photocurrent flow for volume excitation is one hundred times larger than that for surface excitation; this result indicates a fairly homogeneous distribution of sensitizing centres through the volume of the crystal. A tentative description of conductivity and photosensitivity characteristics is given in terms of the various types of vacancies likely to be participating.

537.312.5 : 621.383.4

1472. PROPERTIES OF CADMIUM SULPHIDE PHOTOCONDUCTIVE CELLS. R.L.Williams. Canad. J. Phys., Vol. 36, No. 5, 1536-50 (Nov., 1958).

Measurement of the noise spectra of cadmium sulphide photoconductive cells from 10 to 10 Mc/s has failed to reveal a transition from the 1/f to the $1/f^2$ noise frequency dependence. This clearly demonstrates a complete lack of dependence of the 1/f noise spectrum on the photoconductive time constant, which is approximately 30 msec. No noise correlation has been observed, indicating a minority carrier lifetime of less than $10^{-7}$ sec. The extreme difference between the minority carrier lifetime and the photoconductive time constant is explained by assuming that most of the recombination takes place at the surface of the film, but that the rate of recombination is controlled by diffusion. Slow diffusion of the minority carriers is a consequence of their very short lifetimes. The noise power and time constants of CdS have been observed to depend on the value of the series resistance used with the cell. The two effects are believed to be related and to arise from the presence of intercrystalline barriers.

537.312.5 : 541.14

1473. PHOTOCHEMICAL EFFECTS AND THE EFFECT OF OXYGEN ON PHOTOCONDUCTING CADMIUM SULPHIDE CRYSTALS. J.Woods. J. Electronics and Control, Vol. 5, No. 5, 417-26 (Nov., 1958).

Single crystals of cadmium sulphide can be activated to give high photoconductive sensitivity in a variety of ways. Experiment shows that crystals containing a non-stoichiometric excess of cadmium in the form of sulphur vacancies are inherently unstable. Their photoconductivity decays under illumination and on exposure to an ambient atmosphere containing oxygen. This instability can be eliminated by using an activation treatment which does not produce sulphur vacancies. The photochemical effects and the effects of heat treatment in oxygen on a number of differently activated crystals were investigated with particular reference to the shallow electron trapping effects produced. Further support has been obtained for the ideas advanced in an earlier paper, in which an attempt was made to identify the defects responsible for the well-defined peaks in the thermally stimulated current curve. These ideas are extended in the present paper to account for some aspects of the photochemical decay and the effects of heat treatment in oxygen.

537.312.5 : 537.312.8

1474. A NEW PHOTOMAGNETOELECTRIC EFFECT IN GERMANIUM. M.Cardona Castro. An. Real Soc. Espan. Fis. Quim., Vol. 54(A), No. 5-6, 121-6 (May-June, 1958). In Spanish.

A new photomagnetoelectric (quadratic) effect was discovered in germanium by the author, who develops the theory of this effect in good agreement with the experimental results.

537.312.5

1475. PHOTOCONDUCTIVITY IN LEAD SELENIDE. D.H.Roberts. J. Electronics and Control, Vol. 5, No. 3, 256-69 (Sept., 1958).

Photoconductivity was investigated in solid filaments, chemically deposited films and evaporated films of PbSe, with special reference to the effects of oxygen in the sensitization process and the nature of the recombination mechanism. In the solid filaments, recombination is thought to be through Shockley–Read centres rather than by a photon-radiative process. Results obtained from measurements on chemically deposited films indicate the presence of potential barriers which are related to the rate of deposition of the film and the effect of which is to reduce the concentration of charge carriers in the dark. Oxygen absorbed on to the film increased the dark conductivity but did not affect the total d.c. photosensitivity, suggesting that the carrier mobility had been increased. The spectral response curves for evaporated films showed a peak at 1 $\mu$, which can be explained in terms of the potential barriers found in chemically deposited films, and an apparent variation in quantum efficiency between 1.5 and 3 $\mu$, due to surface recombination. In the sensitization process, oxygen is thought to reduce the dark carrier concentration and remove potential barriers by filling selenium vacancies, and to increase the carrier lifetime by reducing the surface recombination velocity.

C.H.B.Mee

537.312.5 : 537.531

1476. THE EFFECT OF X-RAYS ON THE ELECTRICAL PROPERTIES [PHOTOCONDUCTIVITY] OF MERCURIC SULPHIDE [HgS]. N.I.Butsko and A.D.Shneĭder. Zh. tekh. Fiz., Vol. 28, No. 6, 1188-9 (1958). In Russian.

537.312.5

1477. PHOTOCATHODES FOR RECORDING THE ULTRAVIOLET, BASED ON ALLOYS OF Mg AND Ba. T.M.Lifshits and N.G.Kokina. Radiotekhnika i Elektronika, Vol. 3, No. 9, 1199-203 (1958). In Russian.

Describes an experimental investigation of the photoelectric character of cathodes prepared by evaporating Mg–Ba alloys in vacuo. The alloys contain 1.1, 2.3, 8.5, 16.2 and 30.5% Ba. The spectral response of these cathodes shows selective characteristics. Both the magnitude and the wavelength distribution of the photo signal depend on the amount of Ba in the alloy. The maximum sensitivity of 17 $\mu$A/mW (obtained with the 30.5% Ba alloy) occurs at 2 900 A , and corresponds to a quantum efficiency of 7%. The work function of the cathode is found to be about 2.4 to 2.5 eV. The effect of the composition and thickness of the cathodes on their response is shown in several graphs.

W.Bardsley

537.312.5

1478. TRANSIENT PHOTOCONDUCTIVITY IN SILVER CHLORIDE AT LOW TEMPERATURES. R.S.Van Heyningen and F.C.Brown. Phys. Rev., Vol. 111, No. 2, 462-71 (July 15, 1958).

Primary photoconductivity was investigated down to 6.5°K in single crystals of pure AgCl using low intensity, monochromatic light pulses and a sensitive electrometer. Results are presented which are in agreement with a theory of the transient response taking into account light absorption and electron trapping. The electron yield per absorbed photon (quantum efficiency) is found to be high, somewhat less than one, in the long-wavelength tail and through the first peak of optical absorption for all crystals and temperatures

down to 6.5°K. These results agree with the proposed band scheme if one allows for direct and indirect transitions. Electron trapping properties are strongly dependent on sample preparation, but certain features are believed characteristic of the silver halides. Whereas the density of deep (0.5 eV) traps may be very low in well-annealed AgCl, a high density of very shallow (< 0.1 eV) traps exists in the crystals prepared so far. Prominent electrical glow peaks were observed at 15°K, 35°K, and 178°K. No evidence for hole mobility was found and upper limits on possible hole ranges are given.

537.312.5

1479. PHOTORESISTANCES OF TELLURIUM OXIDE [$TeO_2$].
R.Ya.Berlaga and S.N.Chechurin.
Zh. tekh. Fiz., Vol. 28, No. 6, 1174-6 (1958). In Russian.

537.312.5 : 537.311.32

PHOTOCONDUCTIVITY OF SOLID ORGANIC INSULATORS. See Abstr. 1432

537.312.62

1480. THE KNIGHT SHIFT IN SUPERCONDUCTORS.
V.Heine and A.B.Pippard.
Phil. Mag. (Eighth Ser.), Vol. 3, 1046-50 (Sept., 1958).

The Bardeen, Cooper and Schrieffer (BCS) theory of superconductivity (see Abstr. 6193/1957, 1708/1958) predicts a zero Knight shift at 0°K. An analysis of this result shows how it is related to the exact pairing between electrons of opposite $\vec{k}$ and opposite spin in this theory. The analysis and other considerations suggest a modification of the BCS theory, which then gives a Knight shift in reasonable agreement with Reif's (Abstr. 5353/1957) measurements.

537.312.62 : 538.22

1481. PENETRATION DEPTH, SUSCEPTIBILITY, AND NUCLEAR MAGNETIC RESONANCE IN FINELY DIVIDED SUPERCONDUCTORS.
M.Tinkham.
Phys. Rev., Vol. 110, No. 1, 26-9 (April 1,1958).

On the basis of experimental evidence that the effective superconducting penetration depth is increased by a decrease in electronic mean free path, whether by body or surface scattering, and guided by the Pippard (Abstr. 4106/1953) nonlocal theory, it is proposed that many types of experiments on small particles can be interpreted semiquantitatively by taking over the formal results of the London theory with $\lambda_0$ modified to $\lambda_0(1 + \xi_0/l_{eff})^{\frac{1}{2}}$. In this, $\xi_0$ is Pippard's coherence length and $1/l_{eff}$ includes both surface and body scattering. This method gives a good fit to Whitehead's susceptibility data (Abstr. 6337/1957) on colloidal superconducting mercury, but predicts a narrower nuclear resonance line than is observed by Reif in a similar colloid (Abstr. 6652/1956, 5353/1957).

537.312.62

1482. THEORY OF THE ANOMALOUS SKIN EFFECT IN NORMAL AND SUPERCONDUCTING METALS. D.C.Mattis and J.Bardeen.
Phys. Rev., Vol. 111, No. 2, 412-17 (July 15, 1958).

Chambers' expression for the current density in a normal metal in which the electric field varies over a mean free path is derived from a quantum approach in which use is made of the density matrix in the presence of scattering centres but in the absence of the field. An approximate expression used for the latter is shown to reduce to one derived by Kohn and Luttinger for the case of weak scattering. A general space- and time-varying electromagnetic interaction is treated by first-order perturbation theory. The method is applied to superconductors, and a general expression derived for the kernel of the Pippard integral for fields of arbitrary frequency. The expressions derived can also be used to discuss absorption of electromagnetic radiation in thin superconducting films.

537.312.62

1483. MEISSNER EFFECT AND GAUGE INVARIANCE.
G.Rickayzen.
Phys. Rev., Vol. 111, No. 3, 817-21 (Aug. 1, 1958).

It is shown from a manifestly gauge-invariant Hamiltonian that the Meissner effect can follow from an energy-gap model of superconductivity. The superconductor is described by Fröhlich's Hamiltonian and the superconducting properties at the absolute zero are determined by a method due to Bogoliubov. In the weak-coupling limit ($T_c \ll \Theta_D$) there is an energy gap which leads to a Meissner effect. The method of Bogoliubov is extended to apply at general temperatures and the current is calculated in the weak-coupling limit. The results are in essential agreement with those of Bardeen, Cooper, and Schrieffer.

537.312.62

1484. MEISSNER EFFECT. G.Wentzel.
Phys. Rev., Vol. 111, No. 6, 1488-92 (Sept. 15, 1958).

The magnetic properties of the Bardeen–Cooper–Schrieffer model of a superconductor are investigated by means of Bogoliubov's mathematical method. A derivation of the Meissner effect is given which is strictly gauge invariant in every step.

537.312.62

1485. REMARKS ON THE THEORY OF SUPERCONDUCTIVITY.
K.Yosida.
Phys. Rev., Vol. 111, No. 5, 1255-6 (Sept. 1, 1958).

The relation between the Bardeen–Cooper–Schrieffer theory and the Bogoliubov theory of superconductivity is discussed. It is shown that the B.C.S. trial wave-function is derived by the same transformation as that used by Bogoliubov, and that the integral equation which determines an introduced parameter is equivalent. Some remarks are also made on the excited-state wave-functions.

537.312.62

1486. THERMAL PROPAGATION EFFECTS IN THIN SUPERCONDUCTING FILMS. J.W.Bremer and V.L.Newhouse.
Phys. Rev. Letters, Vol. 1, No. 8, 282-4 (Oct. 15, 1958).

Experiments were carried out on the current-induced superconducting–normal transition in a thin tin film. The transition was either started by a short pulse of magnetic field at one part of the film or left to start itself; from observations of the subsequent variation of film resistance with time, it is inferred that the transition proceeds by thermal propagation, due to Joule heating, of normal regions over the film. It is suggested that this process may help to explain why the calculated critical field of such a transition is lower than that associated with a field-induced transition.
L.Mackinnon

537.312.62

1487. SUPERCONDUCTIVITY IN THE TERNARY SYSTEM NIOBIUM–NITROGEN–OXYGEN. G.Lautz and E.Schröder.
Z. Naturforsch., Vol. 11a, No. 9, 767-8 (1956). In German.

A preliminary notice of work reported in the following abstract.
R.G.Chambers

537.312.62

1488. SUPERCONDUCTING COMPOUNDS OF NIOBIUM.
E.Schröder.
Z. Naturforsch., Vol. 12a, No. 3, 247-56 (1957). In German.

Magnetic transitions were studied in Nb–N compounds of varying composition, some containing a few per cent oxygen impurity. The oxygen did not greatly affect the transition temperature, but suppressed the hysteresis observed in pure Nb–N compounds. The hexagonal phases, NbN I and $Nb_2N$, did not become superconducting; neither did the compounds NbH and NbD. R.G.Chambers

537.312.62

1489. THE THEORY OF THE EFFECT OF A GROOVE IN A SUPERCONDUCTOR. G.U.Schubert.
Z. Phys., Vol. 152, No. 5, 624-41 (1958). In German.

The London equations are solved for a plane superconducting surface with a groove in it, of semi-circular or semi-elliptical cross-section, running parallel to the magnetic field.
R.G.Chambers

537.312.62 : 538.13

MAGNETIC PROPERTIES OF SUPERCONDUCTORS. See Abstr. 392

537.312.62 : 539.14

POSSIBLE ANALOGY BETWEEN THE EXCITATION SPECTRA OF NUCLEI AND THOSE OF THE SUPERCONDUCTING METALLIC STATE. See Abstr. 583

537.312.62 : 534.23

ULTRASOUND ATTENUATION IN METALS IN THE SUPERCONDUCTING STATE. See Abstr. 1203

537.312.62 : 536.632 : 536.212.2

INVESTIGATION OF THE THERMAL PROPERTIES OF SUPERCONDUCTORS. See Abstr. 1360

537.312.8 : 538.632

490. OSCILLATORY PROPERTIES OF GALVANOMAGNETIC FFECTS IN BISMUTH. T.Okada.
Iem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 4, 156-63 (Jan., 1958).

The oscillatory dependences of the Hall coefficient and the magetoresistance of bismuth on magnetic fields were observed at iquid-helium temperature, and the periods of these oscillations in eciprocal magnetic field were measured for various crystal orientions. Analysing the values of observed periods, the relative values f the mass tensor components for conduction electrons can be deterined, which are nearly concordant with those obtained by Shoenberg Abstr. 5913/1952) for the de Haas–van Alphen effect.

537.323

491. THE PERFORMANCE OF BISMUTH TELLURIDE THERMOUNCTIONS. H.J.Goldsmid, A.R.Sheard and D.A.Wright.
3rit. J. appl. Phys., Vol. 9, No. 9, 365-70 (Sept., 1958).

The thermoelectric properties of n-type and p-type bismuth elluride between 150° and 300° K were measured and the figure of nerit for thermoelectric applications was calculated. This figure f merit was shown to be highest for material with an electrical conuctivity of about 1000 $ohm^{-1}\ cm^{-1}$ with current flow parallel to leavage planes. Its value at 290° K corresponds to a maximum cooling by means of the Peltier effect of about 65° C, and an efficiency of hermoelectric generation of 1% for a 25 deg C temperature differnce.

537.323

492. SPECIAL TECHNIQUES FOR MEASUREMENT OF THERMOELECTRIC PROPERTIES. T.C.Harman.
. appl. Phys., Vol. 29, No. 9, 1373-4 (Sept., 1958).

A method for determining thermoelectric power by balancing ie Peltier heat against the heat conducted through a currentarrying wire specimen, under conditions such that Joule and Thomson heating can be neglected. M.R.Hopkins

537.323

493. THERMO-ELECTRIC OBSERVATIONS ON GREY ELENIUM. J.I.Carasso and R.W.Pittman.
'ature (London), Vol. 182, 1011 (Oct. 11, 1958).

Oriented polycrystals, having the preferred c-axis parallel to ie growth direction, were found to yield a thermoelectric power ncreasing with temperature and to show hysteresis effects and ecular changes. Monocrystals showed a thermoelectric power ndependent of temperature and of thermal history.

C.A.Hogarth

537.36 : 534.2

494. LABORATORY REPRODUCTION OF THE SEISMOELECTRIC EFFECT OF THE SECOND KIND. M.S.Antsyferov.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 5, 827-9 (1958). In Russian.

The e.m.f. developed along a slate rod was measured when lastic vibrations from a piezoelectric generator where transmitted long the rod. Resonance effects were found. J.M.Hough

# ELECTRIC DISCHARGES

537.521

495. INVESTIGATIONS ON THE EXISTENCE RANGE OF THE ELECTRODELESS RING DISCHARGE. H.J.Strauss.
Ann. Phys. (Leipzig), Folge 7, Vol. 1, No. 4-5, 281-95 (1958).
n German.

Examines the existence range of ring discharges as a function f pressure and exiting frequency in the range 4 to 8 Mc/s. Studies vere conducted in the inert gases, Hg, $N_2$, $O_2$, Br and I.

C.G.Morgan

537.521.6

496. ULTRA-HIGH-FREQUENCY GAS BREAKDOWN BETWEEN ROGOWSKI ELECTRODES. W.A.Prowse and J.L.Clark.
Proc. Phys. Soc., Vol. 72, Pt 4, 625-34 (Oct., 1958).

Electrons may be removed from the gas between a pair of lane parallel electrodes by being swept out by the field, by ecombination, by attachment or by diffusion. At high enough requencies diffusion is the most likely mechanism. This can be ested quantitatively by plotting the relation between EΛ and pΛ E = electric field required to produce breakdown, p = gas pressure, Λ = "diffusion length" for the gap). It can also be tested qualitaively by observing the decrease of E with increasing gap width d. The electrodes must be properly profiled to avoid breakdown beginning at the edges. The necessary observations of breakdown voltage, electrode spacing, electrode size, and gas pressure are made for air, hydrogen, nitrogen and neon, at 9.5 Mc/s. The (EΛ, pΛ) plot gives a single line for ultra-high-frequency breakdown and E decreases with increasing d in accordance with diffusion theory. Values of the ionizing efficiency $\eta$ are calculated.

537.523.5

1497. ON THE PERTURBATION OF AN ARC BY IMMERSED PROBES. G.Müller.
Z. Phys., Vol. 151, No. 4, 460-82 (1958). In German.

Perturbation effects caused by the introduction of probes were examined by oscillating thin wires through a high-current free-burning arc in argon. The disturbing effects were examined and related to the mechanism of the origin of the perturbation. According to this study the perturbations have two components: (1) a pure thermal effect caused by the thin probe in passing through the arc axis as the effect of partially obstructing the main discharge channel and (2) an electrical effect resulting from the shape of the current–voltage characteristic of the portion of the arc parallel to the probe sheath and of a plasma current in the arc and finally the cathode mechanisms. C.G.Morgan

537.525

1498. ON THE MECHANISM OF APPEARANCE OF STRIATIONS IN THE POSITIVE COLUMN OF A GAS DISCHARGE. I.M.Chapnik.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1496-503 (1958). In Russian.

It is shown that the appearance of striations in the positive column cannot be explained by instability of the homogeneous column. Non-linear equations are obtained for the electron temperature and potential gradient which yield periodic solutions. The equations are deduced from the equations of conservation of particles under the assumption that variation of the charged particle density along the column is negligible. The column is striated or homogeneous depending on the boundary conditions at the cathode end.

537.525 : 537.565

1499. STUDY OF THE TRANSVERSE MOTION OF IONS IN A DISCHARGE IN A STRONG LONGITUDINAL MAGNETIC FIELD. A.Zharinov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1803-10 (1957). In Russian.

The relation between the direction of the mean transverse ion velocity and gas pressure was investigated. A flat, rotating double probe was used to determine the direction of the ion velocity. It was found that in argon at pressures below $3 \times 10^{-3}$ mm Hg a strong magnetic field (~ 2300 Oe) did not prevent a considerable number of ions from reaching discharge-tube walls without collisons on the Electrical Research Association

537.525 : 621.387

1500. THE ANODE REGION IN LOW-PRESSURE GAS DISCHARGES. I. EFFECT OF THE ANODE SHAPE ON THE SIGN AND MAGNITUDE OF THE ANODE DROP.
V.N.Klyarfel'd and N.A.Neretina.
Zh. tekh. Fiz., Vol. 28, No. 2, 296-315 (1958). In Russian.

The anode phenomena in a mercury discharge were investigated in the three most typical cases: a cylindrical hollow anode, a hemispherical anode of diameter = 0.3 column diameter, and a flat anode. The pressures were less than 0.1 mm Hg, discharge currents 0.03-10 A, column diameter 32 mm. Hollow and hemispherical anodes always had anode drops of equal magnitude and opposite signs. Temperature rises to 700-800° C do not alter anode drops. A flat cold anode had mostly negative anode drops, except at currents less than 3 A and pressures above 0.001 mm Hg. Electrical Research Association

537.525.8 : 621.387

1501. SPHERICAL PLASMOIDS IN LOW PRESSURE ELECTRODELESS DISCHARGES. E.R.Harrison.
J. Electronics and Control, Vol. 5, No. 4, 319-28 (Oct., 1958).

"Plasmoids", of the kind originally observed by Wood (Abstr. 619,3220/1930), are luminous plasma bodies occasionally found in low-pressure electrodeless discharges. Experiments with spherical plasmoids in argon at a pressure of $10^{-4}$ mm Hg show that the electron temperatures are in the region of $10^5$ to $1.5 \times 10^5$ °C and the electron number density is of the order $10^8\ cm^{-3}$. Plasmoids are affected by the presence of a probe, and variation in the probe potential can cause large changes in the size of the plasmoid. The plasma equation of Tonks and Langmuir, for spherical symmetry and for ion generation proportional to the electron density, is solved and an approximate theory is advanced to explain some of the effects observed.

537.525.8 : 539.18

1502. PRODUCTION OF HIGH CONCENTRATIONS OF HYDROGEN ATOMS. K.R.Jennings and J.W.Linnett.
Nature (London), Vol. 182, 597-8 (Aug. 30, 1958).

Briefly describes the production of atomic hydrogen (about 50-60% content, 25 cm downstream from the source) in a 9.7 Mc/s, 350 W oscillator-excited tube at a pressure of about 0.08 mm Hg. J.D.Craggs

537.525.92

1503. SPACE CHARGE RELATIONS FOR THE LOW-FREQUENCY SILENT ELECTRIC DISCHARGE IN HYDROGEN. D.P.Jatar.
Canad. J. Phys., Vol. 36, No. 11, 1551-6 (Nov., 1958).

The current–potential characteristics in hydrogen under the low-frequency silent electric discharge using an all-glass ozonizer are examined from the standpoint of the Child–Langmuir space charge relation and the modified Townsend–Werner equation. It is concluded that the three distinct regions in the characteristics correspond to the space-charge-free, the space-charge-limited, and the steady corona regimes.

537.527.4

1504. ON THE MECHANISM OF FIELD BREAKDOWN IN COMPRESSED GASES. G.List.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 238-46 (1957). In German.

Theoretical calculations showing how field emission at a rate of about $10^5$ electrons/sec would account for the observed (Abstr. 9222/1957) long statistical time lags in nitrogen at high pressure. J.Dutton

537.527.5

1505. A CONTRIBUTION TO KNOWLEDGE OF THE ARC DISCHARGE WITHOUT CATHODE SPOTS. W.Haidinger.
Z. Phys., Vol. 151, No. 2, 106-13 (1958). In German.

Examines conditions leading to changes from arcs with cathode spots to spotless arcs in a high pressure, short length, xenon arc. The change was found to depend upon the form and emission of the cathode. A special cathode, coated with easily emitted material is described with which the transition current is reduced by approximately 40%. With arcs at low current strengths and without cathode spots a re-ignition peak was observed. C.G.Morgan

# X-RAYS

537.531 : 539.14

NUCLEAR SIZE ESTIMATES FROM X-RAY FINE STRUCTURE MEASUREMENTS. See Abstr. 576

# ELECTRON EMISSION. ELECTRON BEAMS

537.533 : 621.38

1506. SPACE-CHARGE WAVES. A.H.W.Beck.
London/New York/Paris/Los Angeles: Pergamon Press (1958) 396 + xi pp. [International Series of Monographs on Electronics and Instrumentation, Vol. 8].

This monograph is an attempt to present a unified model capable of describing the small-signal operation of all modern microwave valves, except cavity magnetrons. The presentation is based on the study of the interaction of space-charge waves on the electron beam with waves on the circuit, which have to be slowed down so as to have phase velocities nearly equal to the electron velocities. Appendices contain analyses requiring heavy algebra and some topics out of place in the main text, for instance, measurements on slow-wave structures and the theory of focusing high current beams. A small selection of problems is included. Some 250 references, up to early in 1958 are given. Tables and graphs are used to present the more important design information. Where sufficiently detailed experimental material is available it is compared with the theory. Some original matter on space-charge waves on annular beams and on effects in klystrons is included. A.H.W.Beck

537.533 : 537.56

1507. A VARIATIONAL PRINCIPLE AND AN ENERGY THEOREM FOR SMALL-AMPLITUDE DISTURBANCES OF ELECTRON BEAMS AND OF ELECTRON–ION PLASMAS. P.A.Sturrock.
Ann. Phys. (New York), Vol. 4, No. 3, 306-24 (July, 1958).

Small-amplitude disturbances of electron beam and electromagnetic field configurations may be conveniently represented by the electromagnetic potentials of the field perturbation and the displacement (or "polarization") vector representing the perturbation of the electron assembly. With this choice of dynamical variables, it is possible to establish a Lagrangian function for small-amplitude disturbances, in which both field and particles are described by "field-like" variables. This derivation is carried through in relativistically covariant form. It is shown that, by a variant of a formula due to Schrödinger, one may establish an acceptable formula for the energy-momentum tensor of the field-particle assembly. The more important formulae are given also in non-relativistic three-dimensional form. The differential equation satisfied by the energy-momentum tensor represents a generalization of the so-called "power theorem" of electron-tube theory. It is anticipated that this variational principle, which may be readily extended to include a number of beams, or a distribution of electron velocities, will provide a convenient basis for certain electron-tube analyses, and for the investigation of certain stability problems in plasma physics.

537.533 : 537.534 : 539.1.07

CONTINUOUS ENERGY MONITOR FOR THE EXTERNAL BEAM OF A CYCLOTRON. See Abstr. 496

537.533.2

1508. A CONTRIBUTION TO THE EXPLANATION OF COLD ELECTRON EMISSION. H.Drost and H.Pupke.
Exper. Tech. der Phys., Vol. 4, No. 6, 272-5 (1956). In German.

A brief, critical review of the theories of exo-electron emission from metals. A model due to Seeger (Abstrs. 6202, 7124/1955), in which emission originates from electron traps in a semiconducting oxide layer, is favoured, and it is shown how previous theories may be related to this concept. C.H.B.Mee

537.533.2 : 537.525.2

1509. A NEW PHENOMENON OF ELECTRON EMISSION FROM THIN MERCURY FILMS. H.von Bertele.
Nature (London), Vol. 182, 1148-9 (Oct. 25, 1958).

A high-vacuum apparatus is described in which the phases of electron emission in a mercury arc may be studied. A new phenomenon, emission from a thin film of condensed mercury, was observed; it is suggested that this may be the true basic emission mechanism. No theory for the effect is advanced, but it is concluded that neither very high current densities nor the evaporation of metal is required for electron emission from the surface of the liquid metal. C.H.B.Mee

537.533.2

1510. ON THE ENERGY OF EXO-ELECTRONS. G.Bathow.
Naturwissenschaften, Vol. 45, No. 16, 381 (1958). In German.

An investigation is described in which the rate of emission of exo-electrons from pulverized emery powder on a lead plate is determined, using a procedure reported in a previous paper (Abstr. 451/1957). The results suggest that the lower limit of the average total energy of the exo-electrons is 0.65 eV. C.H.B.Mee

537.533.2

1511. THE TEMPERATURE DEPENDENCE OF X-RAY STIMULATED EXO-ELECTRON EMISSION.
H.Hieslmair and H.Müller.
Z. Phys., Vol. 152, No. 5, 642-54 (1958). In German.

"Glow curves" of exo-electron emission (see Abstr. 6238-6255/1957), for uniform rise of temperature after X-ray irradiation, are obtained for metals, oxides and sulphides. Etched metals show two emission maxima at 160° and 260°C, while metals heated in air before stimulation show peaks at 10°, 60°, 140° and 200°C. Metallic oxides have a maximum at 160°C, and sulphides a maximum at 140°C. The peak positions are relatively independent of the metal present and are likely to be characteristic of trapped electrons in adsorbed surface layers. G.F.J.Garlick

537.533.2

1512. CONFIRMATION OF THE ANOMALOUS ENERGY DISTRIBUTION IN ELECTRON BEAMS (CONTINUOUS RECORDING METHOD FOR CAUSTIC PATHS OF THE BEAMS). W.Dietrich.
Z. Phys., Vol. 152, No. 3, 306-13 (1958). In German.

The electrostatic velocity analyser recently described by the author (Abstr. 8039/1958), used as a continuous recording instrument, was applied to determinations of the energy distribution of thermally emitted electrons from W at 2600°K and from a BaO cathode at 1460°K. The results are presented as a confirmation of work by Boersch (Abstr. 1953/1955) and by the author (Abstr. 8813/1958). In general, for small current densities, the distribution is asymmetrical: theoretical Maxwellian distributions have been calculated from the position and height of the maxima of these curves, and the theoretical curves have half-widths rather smaller than those determined experimentally. For greater current densities, the distribution becomes symmetrical and Gaussian. Curves are given relating the half-width of the distribution to the emission current density. For emission from the BaO cathode, the half-width is found to decrease with increasing operating time. C.H.B.Mee

537.533.3

1513. CONTRIBUTION TO THE STUDY OF THE NUMERICAL CALCULATION OF FIELDS AND TRAJECTORIES IN THE ELECTRON OPTICS OF CYLINDRICAL SYSTEMS. M.Laudet.
Ann. Fac. Sci. Univ. Toulouse, Vol. 20, 111-230 (1956; publ. 1957). In French.

An extensive treatise giving, in the first part, full details of the relaxation method of potential determination with square, triangular and other meshes, together with applications to several particular practical problems. The treatment of boundary conditions at infinity is discussed. Extrapolation of potentials obtained with successively smaller nets is shown by comparison with analytical solutions to lead to high accuracy. In the second part, the trajectory equations of cylindrical electron lenses (electrostatic and magnetic) are fully developed and expressions for aberrations are tabulated. The particular case of the symmetrical three electrode slit lens is treated both analytically and numerically.
A.E.I. Research Laboratory

537.533.3

1514. EXPERIMENTAL AND THEORETICAL INVESTIGATION OF A NEW ELECTRON-OPTICAL DEFLECTING DEVICE (ABLENKORGAN). J.Picht and R.Gain.
Exper. Tech. der Phys., Vol. 4, No. 6, 262-8 (1956). In German.

In the device the electron beam is deflected during its passage between two plates at the same potential. This is achieved by shaping the plates so that the equipotentials assume the form of a prism. The theory is supplemented by a field study in an electrolytic tank and by measuring deflections in an experimental tube.
A.E.I. Research Laboratory

537.533.3 : 621.385.833

1515. A METHOD OF FOCUSING ELECTRON BEAMS. B.T.Murphy.
Proc. Instn Elect. Engrs, Paper 2719R, publ. 1959 (Part B Suppl. No. 12, 1033-9, 1040).

Describes a method of using reversing magnetic fields to focus electron beams in which considerably smaller permanent-magnet structures are required than with focusing using unidirectional fields. The structures needed are more convenient than those necessary for periodic focusing systems, being applicable to klystrons, for example, and the range of beam parameters over which the method can be used is greater than for periodic focusing systems. It is also probable that beam focusing by reversing-field systems of the type described with few reversals will be less critically dependent on field and beam parameters than in periodic focusing, although the weight-saving advantages of the latter system would be largely retained. The use of an experimental system with one field reversal to focus an electron beam is described.

537.533.3 : 535.31

CHARACTERISTIC CURVES ON IMAGE-SPACE PLANES IN ELECTRON-OPTICAL SYSTEMS. See Abstr. 1236

537.533.33

1516. STIGMATIC IMAGING IN ROTATIONALLY ASYMMETRICAL ELECTRON LENSES. F.Lenz.
Optik, Vol. 15, No. 7, 393-7 (July, 1958). In German.

A small asymmetrical disturbance in an otherwise rotationally symmetrical field introduces a first-order astigmatism and a first-order distortion, additional to the normal abberations of the undisturbed lens. In the object plane of such an asymmetric lens there will exist a point for which the normal (Seidel) astigmatism is balanced by the adventitious astigmatism due to the disturbed field. Such a point will be imaged stigmatically, being affected only by spherical abberation, provided that the imaging beam can be properly centred on it; that is, it now has the properties of the axial point in a rotationally symmetrical field. If this point can be found experimentally and the beam aligned upon it, a resolution should be obtained equal to that reached by using a stigmator to correct rotational asymmetry. A numerical example, assuming a bell-shaped field of strength ($k^2$) equal to unity, and a degree of astigmatism ($2\mu$) normal in a magnetic lens, shows that the stigmatic object point would be about $130\mu$ off the axis. V.E Cosslett

537.533.331

1517. THE SYSTEMATICS OF ASYMMETRICAL UNIPOTENTIAL LENSES. K.J.Hanssen.
Optik, Vol. 15, No. 5, 304-17 (May, 1958). In German.

It is shown that the increase in cross-section of an initially parallel beam, in telescopic operating conditions of an asymmetrical unipotential lens, is a measure of the change in lens power due to introduction of that degree of asymmetry. Relations are derived which agree well with measurements made on two asymmetrical lenses, even in the region of maximum power. The variation of the lens power with voltage ratio in this region can be equated to that of a system of two thin lenses, at fixed separation and with focal lengths in a constant ratio but individually variable. The value of the ratio is determined by the enlargement of the beam cross-section in the telescopic condition. The principal points of this equivalent system behave similarly to those of the actual lens. This method of finding the degree of lens asymmetry from telescopic observations can also be usefully applied to magnetic lenses. V.E.Cosslett

537.533.331

1518. CORRECTION OF THE SPHERICAL ABERRATION OF ELECTROSTATIC LENSES BY SPACE CHARGE. G.Haufe.
Optik, Vol. 15, No. 9, 521-37 (Sept., 1958). In German.

A space-charge lens has been constructed, the basic elements of which are a ring cathode, grid and anode, concentrically arranged about the axis of an electrostatic electron microscope. The space charge formed at the axis, consisting of both electrons and positive ions, acts as a weak lens having spherical aberration of opposite sign to that of the normal objective lens. Experiments on the imaging of a metal mesh show that the space-charge conditions can be controlled so as to correct the spherical aberration of the final image. The magnification was 2500 times, the accelerating voltage of the microscope 10-20 kV, and the prevailing pressure $10^{-3}$ mm Hg. No blurring of the image, due to scattering in the space charge, was observed. V.E.Cosslett

537.533.331 : 621.385.833

1519. CALCULATION OF THE ELECTROSTATIC FIELD OF SYSTEMS OF DIAPHRAGMS. B.É.Bonshtedt.
Zh. tekh. Fiz., Vol. 28, No. 8, 1801-8 (1958). In Russian.

A method of calculating the electrostatic field of a system of plane diaphragms containing circular apertures by the combination of several integral expressions is developed and applied to an immersion objective electrostatic lens. Coefficients required for application to practical cases are evaluated numerically and presented in tabular form. A.E.I. Research Laboratory

537.533.332 : 621.385.833

1520. SHORT QUADRUPOLE MAGNETIC LENSES. I.I.Tsukkerman.
Zh. tekh. Fiz., Vol. 28, No. 8, 1809-12 (1958). In Russian.

Expressions for the focal lengths and magnifications of short quadrupole magnetic electron lenses are given, and applications to focusing in cathode-ray tubes are described.
A.E.I. Research Laboratory

537.533.332

1521. VARIABLE MAGNETOSTATIC LENS SYSTEMS FOR ELECTRON MICROSCOPES. K.Müller.
Z. wiss. Mikr., Vol. 63, No. 5, 303-28 (June, 1957). In German.

Various types of permanent magnet system suitable for electron microscope lenses were investigated in detail. Variation in strength is obtained by use of adjustable gaps and magnetic shunts. The construction of a three-lens and a four-lens electron microscope is described, in which a number of different pole-piece designs were tried out. The best results show a resolution approaching 20 A, when a stigmator was incorporated. V.E.Cosslett

537.533.332 : 621.385.833

1522. A TWO-STAGE PERMANENT MAGNET PROJECTOR SYSTEM FOR ELECTRON MICROSCOPES.
B.v.Borries and G.Langner.
Z. wiss. Mikr., Vol. 64, No. 1, 30-7 (Nov., 1958). In German.

A projector lens system with variable magnification has been designed, with the requirements of reflection and emission electron microscopy particularly in mind. It embodies a permanent magnet circuit with two gaps. The chief problem is to keep distortion at the minimum compatible with the largest possible variation in magnification. It is solved by using a pole-piece assembly which is of variable gap width and which can be moved as a whole across the gap in the yoke. The magnification can be varied from 40 to 800 times, with an image distance of 33 cm at a beam voltage of 50 kV. The permanent magnet has a strength equivalent to 1775 AT. Good agreement was found between the calculated and measured focusing properties of the projector. V.E.Cosslett

537.533.35 : 533.59

1523. OPERATING CONDITIONS OF THE LOW-TEMPERATURE FIELD-EMISSION MICROSCOPE. E.W.Müller.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 315-21 (1957). In German.

The field emission microscope of the author using helium ion emission has a better resolving power than any other form of electron microscope, since it can resolve the atomic lattice of tungsten (2.74 A). The mechanism of image formation is still not fully understood in all its details. The present paper describes experiments to clarify this. The paper also indicates how a demountable vacuum system can be constructed for the study of work-hardening of metals at an atomic level. A.E.I. Research Laboratory

537.533.35

1524. THE CLEANING OF APERTURE AND OBJECT DIAPHRAGMS FOR THE ELECTRON MICROSCOPE.
G.G.Calapaj and L.Squeri.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 3, 197-200 (1956). In Italian.

Platinum diaphragms were found to be badly corroded and the apertures approximately doubled in diameter after cleaning by the methods previously recommended (fusion with a mixture of sodium and potassium hydroxides and sodium nitrate, followed by washing in nitric acid, or fusion with potassium oxalate after treatment with boiling chrom-sulphuric acid, and subsequent washing in strong sulphuric acid). An improved method has been developed without these objectionable results. It involves fusion with sodium borate in a platinum crucible, cooling, adding sodium carbonate and re-fusing, and then dissolving the fused mass in 10% HCl. The diaphragms are kept in boiling distilled water for several hours, washed in alcohol and finally brought to red heat in a platinum crucible.
V.E.Cosslett

537.533.35 : 621.385.833

1525. AN ELECTROSTATIC–MAGNETIC ALINEMENT SECTION FOR THE ELECTRON MICROSCOPE.
M.E.Haine, A.W.Agar and T.Mulvey.
J. sci. Instrum., Vol. 35, No. 10, 357-9 (Oct., 1958).

A compact electron beam shift and tilt system, using electric and magnetic fields in place of the normal mechanical system, is described. This improves mechanical stability and permits reflection electron microscopy up to angles of beam tilt of $20^0$.

537.533.35 : 621.385.833

1526. IMAGE INTENSIFIER FOR THE ELECTRON MICROSCOPE.
M.E.Haine, A.E.Ennos and P.A.Einstein.
J. sci. Instrum., Vol. 35, No. 12, 466-7 (Dec., 1958).

An image intensifier is described in which a thin layer of selenium is placed in the electron microscope. The imaging beam causes the selenium to become conducting and potential restoration is provided by an auxiliary scanning beam which produces a television display signal. The device is extremely sensitive and useful images can be obtained with electron microscope beam current densities of the order of $10^{-11}$ A/cm$^2$.

537.533.35

1527. CHROMATIC ABERRATION AND RESOLVING POWER OF ELECTRON MICROSCOPES. W.E.Meyer.
Optik, Vol. 15, No. 1, 43-6 (Jan., 1958). In German.

The effect of chromatic aberration on the resolving power of electron microscopes is calculated approximately. In contradiction to the usual estimations the resolution limit in the case of very large chromatic aberration is found to exceed the one resulting in the case of vanishing chromatic aberration by only a factor of 1.4.

537.533.35

1528. COMPENSATION OF THE CHROMATIC FIELD ABERRATION IN THE ELECTROSTATIC ELECTRON MICROSCOPE.
W.Weitsch.
Optik, Vol. 15, No. 8, 492-9 (Aug., 1958). In German.

Projection lenses of electrostatic type are usually designed to be free from distortion and also from chromatic difference in magnification across the field. The objective has to be operated in slightly different conditions, to ensure that the front focus is in field-free space, and it may then have considerable chromatic field aberration, which causes undue confusion in the image when the specimen is thick enough to produce appreciable voltage loss of the electron beam. Partial compensation can be made by operating the projection lens in conditions giving distortion of opposite sign to that of the objective. Compensation over a wider field can be obtained if two projection stages are employed, and the operating points of the two projectors are correctly chosen. A slight distortion of the final image, or a greater restriction of the image field, must then be tolerated, however. V.E.Cosslett

537.533.35

1529. NOTE ON ACCELERATING COMPONENTS IN PARTICLE SPECTROMETERS. H.Mendlowitz.
Rev. sci. Instrum., Vol. 29, No. 8, 701-3 (Aug., 1958).

Some considerations on "energy aberrations" in electron spectrometers containing accelerating (decelerating) components are discussed with regard to their role in the measurement of the energies of electrons. Based on these considerations, design criteria are obtained for an electrostatic decelerating component for a given electron absorption spectrometer. The design criteria are derived by treating the problem of a charged particle in an electrostatic field by means of the Hamiltonian method in classical mechanics, and are found to be related to the curvature of the electrostatic field.

537.533.35

1530. THE LARGE-ANGLE TWO-DIRECTIONAL FOCUSING OF THE BETA SPECTROMETER. G.Lehr.
S.B. Gesell. Beförd. Naturwiss. Marburg, Vol. 78, No. 2, 47-82 (1955). In German.

It is shown that for arbitrary focusing angles higher-order focusing can be obtained independent of the aperture. Formulae for the suitable magnetic field are given to the fifth order. The equations for the paths of charged particles in an inhomogeneous cylindrically symmetrical field have been calculated to the fourth order. From this it is possible to obtain the inhomogeneity of the field which yields simultaneously the focusing of the first order, the vertical focusing, and the higher-order focusing. It is shown that axial defocusing of the second order can be reduced by means of an elliptic baffle. Furthermore a field of reasonably good focusing property is given for cases of equally large radial and axial apertures.
E.W.Kellermann

537.533.74

1531. THE BACK-SCATTERING OF ELECTRONS IN THE ENERGY RANGE FROM 10 TO 100 KeV. H.Kanter.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 144-66 (1957). In German.

The back-scattering of directed beams of electrons was measured for aluminium, copper, silver and gold targets. A $90^0$ spectrometer was used to determine the energy distribution of the backscattered electrons. The results are compared with those of previous authors. A.E.I. Research Laboratory

537.533.75

1532. THE TRANSMISSION OF ELECTRONS THROUGH METALLIC FOILS. B.N.C.Agu, T.A.Burdett and E.Matsukawa.
Proc. Phys. Soc., Vol. 72, Pt 5, 727-32 (Nov., 1958).

Electron transmission measurements, using a collecting cup and galvanometers, were made for homogeneous energy beams in the range 0.25-0.75 MeV in foils of Be, Al, Cu, Ag and Au. The discrepancy between the present measurement of extrapolated range in aluminium and the generally accepted range–energy relationship cannot be simply explained in terms of low energy secondary emission or geometrical effects. Transmission measurements through silver foils agree, however, with other published results. The angular distribution of electrons emerging from the exit side of a foil was examined. This appears to approach a cosine distribution at low transmissions. Further information on range values, and some confirmation of voltage calibration was obtained from ionization in depth measurements.

# ION EMISSION. ION BEAMS

537.534

1533. A HIGH-FREQUENCY ION SOURCE WITH GOOD ION YIELD. E.Cilenšek.
"J. Stefan" Inst. Rep., Vol. 1, 45-8 (July, 1953). In German.

An ion source is described which is suitable for pressurized high voltage generators. A gas discharge is maintained by an h.f. source of 60 W, 80 Mc/s. The source was designed to give a higher output than previous designs. A.E.I. Research Laboratory

537.534

1534. PROPOSAL FOR A SOURCE OF POLARIZED PROTONS. A.Abragam and J.M.Winter.
Phys. Rev. Letters, Vol. 1, No. 10, 374-5 (Nov. 15, 1958).

A possible method for producing polarized protons for injection into a cyclotron is discussed quantitatively. C.J.Batty

537.534

1535. DEVELOPMENT OF AN OCCLUDED-GAS ION SOURCE. K.W.Ehlers, J.D.Gow, L.Ruby and J.M.Wilcox.
Rev. sci. Instrum., Vol. 29, No. 7, 614-19 (July, 1958).

An ion source for pulsed operation was developed which is based on producing a spark discharge between electrodes of a transition metal in which ordinary hydrogen or deuterium has been occluded. The beam consists principally of ions of hydrogen and of the electrode material. No neutral gas is evolved between pulses. High beam-current densities were obtained, both with axial and with radial extraction. Various methods were devised for filtering out the heavy-mass components of the beam.

537.534.2

1536. THE ION-OPTICAL ABERRATIONS OF A UNIFORM MAGNETIC SECTOR FIELD FOR ARBITRARY ENTRY AND EXIT ANGLE OF THE PRINCIPAL RAY. H.Hintenberger and L.A.König.
Z. Naturforsch., Vol. 11a, No. 12, 1039-40 (1956). In German.

In previous investigations of the deflection of ions in the magnetic sector field, aberrations were evaluated only for normal exit of the beam; for arbitrary entry and exit angle only the spherical aberration was found by Hintenberger (Abstr. 7947/1951). A general expression is now derived for the mixed directional- and momentum-dependent aberration, the pure momentum-dependent aberration and the spherical aberration. It is shown how the earlier results of other authors for one or other of these aberrations, at normal entry or exit, follow from this general expression. V.E.Cosslett

537.534.3

1537. ON THE ABERRATIONS IN DOUBLE-FOCUSING MASS SPECTROMETERS AND MASS SPECTROGRAPHS. H.Hintenberger and L.A.König.
Z. Naturforsch., Vol. 12a, No. 2, 140-7 (1957). In German.

The aberrations of a double-focusing spectrometer are evaluated neglecting end-effects. The system analysed consists of a radial electrostatic field followed by a uniform magnetic field. The conditions for freedom from aberration are stated.
A.E.I. Research Laboratory

537.534.3

1538. THE IMAGE ABERRATIONS OF DOUBLE-FOCUSING MASS-SPECTROGRAPHS. H.Liebl and H.Ewald.
Z. Naturforsch., Vol. 12a, No. 7, 538-40 (1958). In German.

The second-order radial aberrations are calculated for a double-focusing mass-spectrometer, which has a toroidal electrical condenser and a magnetic field of circular boundary at entry. Cylindrical and spherical condensers, and rectilinear magnetic field boundary, are special cases to which the results are applicable.
B.Meltzer

537.534.3

1539. STIGMATIC-IMAGING MASS-SPECTROGRAPHS WITH DOUBLE-FOCUSING PRACTICALLY OF SECOND ORDER. H.Liebl and H.Ewald.
Z. Naturforsch., Vol. 12a, No. 7, 541-4 (1958). In German.

Results of the previous abstract are applied to a discussion of conditions for the vanishing of second-order radial aberrations. It is shown how three of the four aberrations may be eliminated, while the fourth — depending only on ion energy spread — is minimized.
B.Meltzer

537.534.3

1540. FURTHER MASS-SPECTROMETERS WITH COMPLETE DOUBLE FOCUSING OF THE SECOND ORDER. H.Hintenberger and L.A.König.
Z. Naturforsch, Vol. 13a, No. 3, 236-7 (March, 1958). In German.

It is shown that double focusing in mass spectrometers can be achieved to a second order if the magnetic deflector is assigned curved boundaries. Optimal radii of these are determined by the geometry of the rest of the apparatus, and the relative dimensions of a number of such systems are given in tabular form.
A.E.I. Research Laboratory

537.534.3 : 545.827 : 533.16

FRACTIONATION OF GAS IN MASS SPECTROMETER ION SOURCE. See Abstr. 1158

537.534.8 : 539.231

1541. SPUTTERING OF SILVER BY HYDROGEN IONS. C.D.O'Briain, A.Lindner and W.J.Moore.
J. chem. Phys., Vol. 29, No. 1, 3-7 (July, 1958).

The sputtering of silver by the ions $H^+$, $H_2^+$ and $D^+$ was measured by allowing a magnetically analysed beam of ions from a r.f. source to strike a target containing radioactive silver. The angular distribution of the sputtered silver follows approximately a cosine law. At normal incidence and 9250 V energy, the number of atoms sputtered per incident ion is 0.03 for $H^+$, 0.075 for $H_2^+$, and 0.08 for $D^+$. These values are much lower than those of previous workers, and the difference is ascribed to the absence of atoms and excited molecules from the analysed ion beams.

537.534.8 : 539.231

1542. SPUTTERING OF SILVER BY NEUTRAL BEAMS OF HYDROGEN AND HELIUM. A.Weiss, L.Heldt and W.J.Moore.
J. chem. Phys., Vol. 29, No. 1, 7-8 (July, 1958).

When the unanalysed beam from a r.f. ion source strikes a silver target, sputtering is caused by both the ions and the neutral particles in the beam. The sputtering due to neutrals alone was measured by removing the ions from the beam magnetically. For a beam of 40 $\mu$A at normal incidence and 10 kV energy, in the case of hydrogen over 90%, and in the case of helium about 50%, of the sputtering is due to neutrals.

# PARTICLE ACCELERATORS

537.54 : 621.384.6

1543. NEW METHODS OF ACCELERATING PARTICLES. W.Jentschke.
Acta phys. Austriaca, Vol. 11, No. 4, 485-510 (1958). In German.

The author reviews the development of accelerators of the cyclotron type for producing high energy particles. Reference is made to the 6 GeV electron synchrotron being planned in Hamburg, and to the 25 GeV proton synchrotron at Geneva. The application of strong focusing to high energy machines of the fixed-frequency, alternating-gradient type is discussed and future possibilities are evaluated for increasing the beam intensity in high energy accelerators. A.E.I. Research Laboratory

537.54

1544. STABILITY AND ISOCHRONISM IN CYCLOTRONS WITH STAR-SHAPED FIELDS. F.Fer.
C.R. Acad. Sci. (Paris), Vol. 247, No. 15, 1097-8 (Oct. 13, 1958). In French.

Theoretical results for cyclotrons which have a symmetry of repetition of the field around the axis of the magnet, with a period of $2\pi/N$ in azimuth but not in revolution. J.W.Sturgess

537.54 : 621.384.61

1545. FOUR-SECTOR AZIMUTHALLY VARYING FIELD CYCLOTRON. H.G.Blosser, R.E.Worsham, C.D.Goodman, R.S.Livingston, J.E.Mann, H.M.Moseley, G.T.Trammel and T.A.Welton.
Rev. sci. Instrum., Vol. 29, No. 10, 819-34 (Oct., 1958).

An electron model relativistic fixed-frequency cyclotron of the azimuthally varying field type has been constructed for the purpose of testing the orbit dynamics of such a device. An iterative technique used in designing an acceptable magnetic field shape is described in some detail. A brief description of the various components of the

device is given, as well as an account of the beam phenomena observed in the initial period of operation. Results strongly indicate the feasibility, from an orbit dynamics standpoint, of large proton machines of this type.

537.54 : 621.384.612.12

1546. A SIMPLE ORBIT CONTRACTOR FOR BETATRON-STARTED SYNCHROTRONS. J.Moffatt.
J. sci. Instrum., Vol. 35, No. 12, 447-9 (Dec., 1958).

The contractor uses a small thyratron to control the current in a coil around the betatron flux of the machine, the current being supplied by the changing betatron flux. The X-ray yield is increased by a factor varying from three to twenty.

537.543 : 550.385 : 551.594

THE STÖRMERTRON. SIMULATING THE MOTION OF CHARGED PARTICLES IN THE EARTH'S MAGNETIC FIELD.
See Abstr. 956

# IONIZATION. PLASMA

537.56 : 621.387

1547. A TRANSIT TIME RELATION FOR PLASMA ELECTRON OSCILLATIONS. K.G.Emeleus and D.W.Mahaffey.
J. Electronics and Control, Vol. 5, No. 6, 559-60 (Dec., 1958).

A relation found experimentally between tube voltage and oscillation frequency, when plasma electron oscillations are excited in a hot-cathode low-pressure discharge, is shown to be consistent with the usual assumption that modulation of the beam takes place in an oscillating sheet at a short distance from the cathode in the plasma.

537.56

1548. THE CONTAINMENT OF PLASMA BY THE PINCH DISCHARGE. G.Thomson.
Phil. Mag. (Eighth Ser.), Vol. 3, 886-96 (Aug., 1958).

When a strong current is flowing axially in a plasma, with cylindrical geometry, the charged particles of the plasma will be prevented from striking the cylindrical wall both by the self-magnetic field of the current and, in the case of the positive ions, by the electric field due to the negative charge in the region of the current. Calculations are made of these effects, which are relevant to the loss of heat by conduction from a thermonuclear device of the ZETA type. It is shown that in order to reduce the loss of heat by conduction to a value less than the energy generated in the discharge by a thermonuclear reaction in deuterium, it is necessary either to have a magnetic field corresponding to a current of the order of a thousand million amps, or to have a substantial electric field, giving a radial potential difference between the axis and wall of the order of 250-500 kV, together with currents of a few million amps. Reasons are given for supposing that such an electric field would in fact be set up as a concomitant of the current and the reaction.

537.56

1549. MICROWAVE INVESTIGATION OF DISINTEGRATING GASEOUS DISCHARGE PLASMAS. H.J.Oskam.
Philips Res. Rep., Vol. 13, No. 4, 335-51 (Aug., 1958).

The phenomenon of afterglow was investigated both theoretically and experimentally by considering the shift of the resonance frequency of a microwave cavity enclosing the plasma. The following are treated theoretically: (1) the complex conductivity of a plasma at high frequencies; (2) the influence of the various loss processes on the shape of the afterglow curve; (3) the connection between the conductivity of the plasma and the properties of the cavity for various types of cavity. In measuring the frequency shift as a function of time, it is necessary to limit the power of the probing signal (frequency $\cong$ 10 000 Mc/s) to a few $\mu$W. The construction and preparation of the gas containers and the measurements are presented. The disappearance process of the electrons from the plasma in helium is found to be ambipolar diffusion, even at a pressure of 25 mm Hg. The mobility of the $He^+_2$ ions in helium at standard density is $\mu_0(He^+_2) = 17.3 \pm 0.7$ cm/s per volt/cm. In the neon afterglow, however, the electrons disappear at a pressure of 20 mm Hg by dissociative recombination with $Ne^+_2$ ions ($\alpha \cong 2.5 \times 10^{-7}$ cm$^3$/s). An admixture of atoms with a lower ionization potential than that of the main gas is found to have a great effect on the disappearance of the electrons. The afterglow is studied in the binary gas mixtures of helium with a small concentration of neon, argon, or krypton, and also in neon-argon and neon-krypton mixtures. Measurements in these mixtures all show the production of a considerable number of atomic ions of the admixture, even at very low concentrations of the latter. The process concerned in helium-neon is a charge-transfer process between a $He^+_2$ ion and a neon atom; the relevant cross-section is found to be $Q_{ce} \cong 1.5 \times 10^{-15}$ cm$^2$. In the other mixtures the atomic ions are produced by the Penning effect and possibly by the above type of charge-transfer process, which cannot be separated in the present experiment. In all gas mixtures the atomic ions are found to be converted into molecular ions by three-body collisions with an atom of the main gas and an atom of the admixture. The probability of this conversion process proves to depend strongly on the difference between the ionization potential of the main gas and that of the admixed atoms, and is found highest in helium-neon. Moreover, the measurements suggest the conversion of $Ne^+$ ions into $(HeNe)^+$ ions by a three-body collision with two helium atoms.

537.56

1550. SUPRATHERMAL PARTICLES.
E.N.Parker and D.A.Tidman.
Phys. Rev., Vol. 111, No. 5, 1206-11 (Sept. 1, 1958).

The production of suprathermal particles in agitated plasmas bearing magnetic fields is discussed. This is done by setting up a Fokker—Planck equation to describe the phenomenon. The role of such particles in astrophysics and in the problem of the production of thermonuclear power is considered.

537.56

1551. SUPRATHERMAL PARTICLES. II.
E.N.Parker and D.A.Tidman.
Phys. Rev., Vol. 112, No. 4, 1048-51 (Nov. 15, 1958).

See preceding abstract. More refined models for the magnetic fields in the plasma are considered and experiments suggested in order to study this phenomenon.

537.56

1552. STRUCTURE OF A SHOCK WAVE IN FULLY IONIZED HYDROGEN. D.A.Tidman.
Phys. Rev., Vol. 111, No. 6, 1439-46 (Sept. 15, 1958).

The Fokker—Planck equations are used to examine the structure of a shock wave in fully ionized hydrogen. This is done by assuming a bimodal Maxwellian distribution for the protons in the interior of the shock and noting that the electrons are in thermal equilibrium with themselves but not necessarily with the protons. This method is essentially an extension of that used by Mott-Smith in his analysis of the Boltzmann equation for a shock wave in a gas of neutral atoms.

537.56

1553. MAGNETICALLY CONFINED PLASMAS. A.C.Kolb.
Phys. Rev., Vol. 112, No. 2, 291-6 (Oct. 15, 1958).

The propagation of high-velocity shock waves in an axial magnetic field generated by single-turn coils connected in parallel to a condenser bank is investigated. Time-resolved photographs show that the plasma behind the shock front is driven away from the tube walls by the magnetic pressure. This compression heats the ionized gas and maintains a high shock velocity during the transit of the front through the coil. The compressed plasma appears to be stable and undergoes radial oscillations that follow the current oscillations. The interpretation and significance of these observations in controlled thermonuclear fusion research are discussed.

537.56 : 532.5 : 538.3

1554. EQUILIBRIUM OF A MAGNETICALLY CONFINED PLASMA IN A TOROID. M.D.Kruskal and R.M.Kulsrud.
Phys. of Fluids, Vol. 1, No. 4, 265-74 (July-Aug., 1958).

A variety of properties are derived satisfied by any static equilibrium of a plasma governed by the well-known magnetostatic equations. Some of these are local and quite trivial. Others involve integrals over surfaces of constant pressure, which are shown to be topologically toroidal under fairly general assumptions. A variational principle for such equilibria is derived. One of its consequences is to provide a characterization of equilibria by their values of certain invariants. Conditions are obtained (additional to the magnetostatic equations) appropriate to the steady state of a plasma slowly diffusing across a magnetic field out of a topologically toroidal region.

537.56

1555. ON THE IONIZATION AND OHMIC HEATING OF A HELIUM PLASMA.
J.M.Berger, I.B.Bernstein, E.A.Frieman and R.M.Kulsrud.
Phys. of Fluids, Vol. 1, No. 4, 297-300 (July-Aug., 1958).

A method which is used for the ionization and heating of helium plasmas in various stellarator models consists of inducing an approximately constant electric field along the main axial confining magnetic field. The details and results are presented of various calculations pertaining to this method. The gas is assumed initially to be 10% ionized and at a temperature of a few electron volts. The major

approximations on which the calculations are based are (1) Maxwellian velocity distributions for the particles, and (2) negligible charged particle loss across the confining magnetic field. The equations for the power balance and number balance were integrated in time numerically for a variety of initial conditions. The results indicate that temperatures of a few hundred electron volts are attainable within milliseconds with an applied field of the order 0.1 V/cm at densities of $3 \times 10^{13}$ particles/cm$^3$. It was found that the maximum temperature is limited by power loss in bremsstrahlung radiation.

537.56

1556. PLASMA HEATING OF SUPERSONIC AIRSTREAM. R.L.Chuan.
Phys. of Fluids, Vol. 1, No. 5, 452 (Sept.-Oct., 1958).

Air molecules of Mach number 3.5 were shot through a region of 10 Mc/s electric field which caused partial ionization. Further down stream, the free electrons experience decay processes, so that energy they gained from the field was given to the molecules. Air temperatures of 900°C were obtained at 0.4 mm pressure.

D.Walsh

537.56

1557. ENERGY DIFFUSION OF FAST IONS IN AN EQUILIBRIUM PLASMA. V.S.Kudryavtsev.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1558-65 (1958). In Russian.

Energy diffusion of fast ions injected into an equilibrium plasma is considered. The energy distribution of the injected ions is initially monochromatic, the corresponding energy exceeding the mean thermal energy in the plasma. It is assumed in this case that the distribution of the velocity directions is isotropic. The law of approach of the distribution to the Maxwellian is derived. The result can be obtained with help of the superposition principle for arbitrary initial distribution, since the equations are linear.

537.56 : 534.222.2

1558. OBLIQUE SHOCK WAVES IN A PLASMA WITH FINITE CONDUCTIVITY. M.I.Kiselev and V.I.Tseplyaev.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1605-9 (1958). In Russian.

The structure of the front of a shock wave in a plasma with finite conductivity is considered by neglecting its viscosity and thermal conductivity. The conditions of applicability of the approximation are derived. An estimate is made of the width of the wave-front. The limiting angle of propagation of an oblique shock wave in a plasma with infinite conductivity is determined.

537.56 : 539.12

NEUTRON GENERATION FROM STRAIGHT PINCHES. See Abstr. 533

537.562

1559. INVESTIGATION OF AN IONISED GAS BY MEANS OF WEAK ALTERNATING ELECTRIC FIELDS. A.Székely.
Acta phys. Austriaca, Vol. 12, No. 2, 155-71 (1958). In German.

A continuation of the work described previously (see Abstr. 8072/1958) by the same author. A capacitor condenser is filled with plasma and its electrical behaviour is studied. Information is provided on conductivities, self-maintained oscillations in the plasma, etc. Helium at 0.5 mm Hg pressure was used. J.D.Craggs

537.562

1560. SECOND TOWNSEND COEFFICIENT IN OXYGEN AT HIGH PRESSURES. D.J.DeBitetto and L.H.Fisher.
Phys. Rev., Vol. 111, No. 2, 390-4 (July 15, 1958).

The existence of the second Townsend ionization coefficient $\gamma$ in oxygen was demonstrated in the presence of electron attachment. The experiment consisted of measurements of d.c. ionization currents in uniform electric fields at pressures near $\frac{1}{2}$ atm and for electrode separations up to 3 cm. At a ratio of field strength to pressure of 35.4 V (cm mm Hg)$^{-1}$, $\gamma$ was found to be 0.045 for a nickel cathode. This is more than an order of magnitude larger than the values previously found for a nickel cathode in hydrogen and nitrogen. This large value of $\gamma$ compensates for the loss of electron multiplication due to negative-ion formation and results in comparable breakdown potentials for oxygen and nitrogen near atmospheric

protons in atomic hydrogen in the ground and first two excited states. The cross-sections for an excited atom are nearly an order of magnitude larger than those for the ground state.

537.563

1561. MASS SPECTROMETRIC OBSERVATION OF TRIATOMIC IONS IN CHLORINE AND BROMINE GASES.
C.E.Melton, G.A.Ropp and P.S.Rudolph.
J. chem. Phys., Vol. 29, No. 4, 968-9 (Oct., 1958).

In a mass spectrometric study of the photochemical reaction of chlorine with formic acid the ions $Cl_3^+$ and $Cl_3^-$ were observed. They were also detected in pure chlorine. An abortive investigation was made to establish whether any of the trimeric chlorine ions were derived from neutral $Cl_3$. R.Schnurmann

537.564 : 539.18

1562. CHARGE TRANSFER OF PROTONS IN EXCITED ATOMIC HYDROGEN. T.J.M.Boyd and A.Dalgarno.
Proc. Phys. Soc., Vol. 72, Pt 5, 694-700 (Nov., 1958).

Resonance charge transfer cross-sections are calculated for

537.564 : 539.19

DETERMINATION OF THE BINDING ENERGY OF $He_2^+$ FROM ION SCATTERING DATA. See Abstr. 727

537.565 : 538.3

PROPERTIES OF AN IONIZED GAS OF LOW DENSITY IN A MAGNETIC FIELD. See Abstr. 473

537.567 : 551.510.535

PHOTODETACHMENT CROSS-SECTION AND THE IONOSPHERIC DETACHMENT RATE FOR $O_2$. See Abstr. 946

537.568

1563. RECOMBINATION BETWEEN POSITIVE IONS OF CAESIUM AND NEGATIVE IONS OF IODINE IN THE AFTERGLOW. T.H.Y.Yeung.
J. Electronics and Control, Vol. 5, No. 4, 307-12 (Oct., 1958).

The chemical reactions between caesium and halogen vapours at pressures of the order of $10^{-1}$ mm Hg or lower were investigated. It was found that only the reaction in caesium and iodine mixture was sufficiently moderate for its recombination coefficient to be measured. Since caesium has the lowest ionization potential among the elements and iodine has a large value of electron affinity, it is to be expected that in the afterglow following a pulsed radio-frequency discharge in such a vapour mixture, the positive carriers will be caesium positive ions and the negative carriers will be iodine molecular ions, and the de-ionization will proceed mainly by their mutual recombination. On making these assumptions the recombination coefficient $\alpha_i$ was found to be $2.3 \pm 0.7 \times 10^{-8}$ cm$^3$sec$^{-1}$ for the process, $Cs^+ + I_2^- = Cs + I_2$, at room temperature.

537.568

1564. CHARGE EXCHANGE IN THE AFTERGLOW OF AN IODINE DISCHARGE. T.H.Y.Yeung.
J. Electronics and Control, Vol. 5, No. 4, 313-18 (Oct., 1958).

The charge transfer process between negative atomic ions of iodine and iodine molecules was studied in the afterglow of a pulsed discharge in iodine vapour. A wire probe technique was used. The cross-section of the process was found to be $3.7 \pm 0.8 \times 10^{-17}$ cm$^{-2}$ at room temperature.

# COSMIC RAYS

537.591 : 539.1.07

1565. THE OPTICS OF COSMIC RAY TELESCOPES. E.Å.Brunberg.
Ark. Fys., Vol 14, Paper 16, 195-262 (1958).

The directional properties of cosmic-ray telescopes are analysed with regard to both geomagnetic deflection of the primary particles and to the spread in the atmosphere of the secondaries. The concepts "image of a cosmic-ray source" and "polar diagram of a telescope outside the earth's magnetic field" are introduced. Image of a cosmic-ray source is defined as the intensity variation recorded by a telescope during one day. The polar diagram represents the sensitivity of a telescope for different angular positions of a cosmic-ray source element on the celestial sphere. A few examples of calculating polar diagrams are given. The resolving power of cosmic-ray telescopes is discussed.

537.591

1566. MEASUREMENT OF COSMIC-RAY INTENSITY ON AN ARTIFICIAL EARTH SATELLITE.
S.N.Vernov, N.L.Grigorov, Yu.I.Logachev and A.E.Chudakov.
Dokl. Akad. Nauk SSSR, Vol. 120, No. 6, 1231-3 (1958). In Russian.

Preliminary measurements of cosmic-ray intensity, carried out with two independent counters mounted on a satellite, are reported. "Flares" and fluctuations in cosmic-ray intensity were recorded. For example, a 50% increase in cosmic-ray intensity occurred at latitudes above 58° on 7 November 1957. During these measurements the satellite was 225-240 km above the earth's surface.

S.Chomet

# MAGNETISM

537.591

1567. "RADIATION BELT" AND TRAPPED COSMIC RAY ALBEDO. S.F.Singer.
Phys. Rev. Letters, Vol. 1, No. 5, 171-3 (Sept. 1, 1958).

It is suggested that cosmic-ray albedo particles, trapped in the earth's magnetic field, may account for satellite observations of a "radiation belt". The mean lifetime of such particles in the trapping region is deduced, assuming that the rate of leakage equals the total production rate, and an expression is given for the "pitch angle" distribution of the particles at the equator. P.Rothwell

537.591

1568. TRAPPED ALBEDO THEORY OF THE RADIATION BELT. S.F.Singer.
Phys. Rev. Letters, Vol. 1, No. 5, 181-3 (Sept. 1, 1958).

Expressions for the equatorial flux and energy spectrum of the radiation belt are derived on the assumptions that protons are injected into the trapping region of the earth's field by the decay of upward projected neutrons from cosmic-ray stars, that Coulomb scattering leads to leakage from the trap, and that some protons suffer energy loss by collisions. Results are not compatible with data reported by satellites Explorer I and III, but are compatible with preliminary reports from Explorer IV. P.Rothwell

537.591.1

1569. FURTHER OBSERVATIONS ON THE NATURE OF THE CURRENT REDUCTION IN THE PRIMARY COSMIC RAY INTENSITY. M.A.Pomerantz and S.P.Agarwal.
Phys. Rev. Letters, Vol. 1, No. 3, 107-9 (Aug. 1, 1958).

Balloon-borne pulsed ionization chambers were biased to respond principally to nuclear disintegrations produced by fast protons and neutrons, and heavy nuclei with $Z>8$. The results indicate that the flux of heavy nuclei and high-energy protons did not change at a time when the total intensity (measured by a balloon-borne vertical quadruple coincidence counter train containing 7.5 cm of lead) had decreased by $\sim 23\%$; this implies that the current reduction in primary cosmic-ray intensity is a consequence of a change in the cut-off rigidity only. It is suggested that a sharp cut-off of protons, unaccompanied by a corresponding cut-off of heavy nuclei, could be explained by ascribing the observed decrease in primary intensity to the action of a cut-off mechanism at the sun, upon low energy cosmic-rays of solar origin. P.Rothwell

537.591.15 : 539.17

1570. ON THE NATURE OF THE PARTICLES WHICH CARRY AWAY MOST OF THE ENERGY IN THE INTERMEDIATE-ENERGY NUCLEAR COLLISIONS. É.Fridlender and É.Rukenshtein.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 104-10 (1958). In Russian.

The electron–nuclear shower transition curve in a dense absorber is computed by assuming the existence of an energetically preferred particle in each step of the nuclear-cascade process. The fraction of decaying particles in the generating component is estimated by comparing this curve with the absorption in air.

537.591.15

1571. ON THE CASCADE THEORY OF SHOWERS. I.P.Ivanenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 132-6 (1958). In Russian.

The equation for the average number of particles was created in a layer of finite thickness and possessing energies exceeding some given value was solved allowing for collision losses. The solutions obtained are compared with those of the usual cascade theory. An expression was obtained for the mean energy of particles in a cascade shower at any stage of its development.

537.591.15

1572. POLARIZATION EFFECTS IN CASCADE SHOWERS. L.F.Cook, Jr and N.Williams, Jr.
Phys. Rev. Letters, Vol. 1, No. 7, 262-3 (Oct. 1, 1958).

Calculations are made of the transmission of polarization effects through matter by means of electromagnetic cascade showers, using a Monte Carlo technique. Values are given for the average polarization transmitted in a shower, at $\frac{1}{2}$ cm intervals, in lead, for an incident 30 MeV electron polarized forward, on the basis of 500 showers. P.Rothwell

537.591.2

1573. ENERGY SPECTRUM OF PARTICLES BOMBARDING THE EARTH. B.J.O'Brien.
Nature (London), Vol. 181, 521 (Aug. 23, 1958).

In the energy region above $10^9$ eV, cosmic rays follow an integral energy (E) spectrum given by $N \propto E^{-1.5}$. It is pointed out that the estimated fluxes of interstellar and auroral particles appear to fit the straight-line portion of this spectrum extrapolated to lower energies. P.Rothwell

538.082

1574. AN ELECTRODYNAMIC MAGNETIC FIELD GRADIOMETER EMPLOYING A MICROVIBRATION TECHNIQUE. Y.L.Yousef and H.Mikhail.
J. sci. Instrum., Vol. 35, No. 10, 375-7 (Oct., 1958).

A simple arrangement is described for measuring magnetic field inhomogeneity in any direction to an accuracy of at least $10^{-3}$ G/cm. The essential part is a very small coil fed by a low frequency a.c. so as to possess an alternating moment and is held, in the (inhomogeneous) magnetic field under test, at the end of a clamped-free elastic reed. When the coil axis is set parallel to the lines of force, it will experience an alternating electrodynamic force (proportional to the field gradient) having a component parallel to the field direction and two other components across the field direction. The coil can follow one or the other of these forces according to the way in which it is constrained to move. The problem thus resolves itself into microvibration measurement. A capacity pick-up circuit is used for this purpose.

538.113/.114

1575. THE CONCEPT OF TEMPERATURE IN MAGNETISM. J.H. Van Vleck.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1081-100 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114 : 538.632

1576. HALL EFFECT IN FERROMAGNETICS. J.Smit.
Nuovo Cimento Suppl., Vol. 6, No. 3, 1177-82 (1957).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1956.

538.114

1577. ON THE SPIN-WAVE THEORY OF FERROMAGNETISM. K.Meyer.
Z. Naturforsch., Vol. 11a, No. 10, 865-73 (1956). In German.

It is shown that the excited states of a ferromagnetic crystal with only one valence electron per atom can be described in terms of a system of spin-waves obeying Fermi–Dirac statistics. A procedure for calculating the states taking into account interactions between nearest neighbours is described, and is applied to the determination of the ground state of systems with a negative exchange integral. A.E.De Barr

538.114 : 539.12

1578. MULTI-MAGNON PROCESSES IN THE SCATTERING OF SLOW NEUTRONS IN FERROMAGNETICS. S.V.Maleev.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1518-25 (1958). In Russian.

The total cross-section for inelastic scattering of neutrons in ferromagnetics involving the scattering of a magnon and emission of another is computed. It is shown that the cross-section is small compared with the cross-section for scattering accompanied by absorption or emission of a magnon. It is also shown that the role of scattering processes in which more than two magnons participate is negligible.

538.114

1579. CONTRIBUTION TO THE PHENOMENOLOGICAL THEORY OF KINETIC PROCESSES IN FERROMAGNETIC DIELECTRICS. I. RELAXATION IN A GAS OF SPIN WAVES. M.I.Kaganov and V.M.Tsukernik.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1610-18 (1958). In Russian.

The relaxation time in ferromagnetic dielectrics due to interaction between spin waves is computed.

538.114

1580. ON THE GROUND STATE OF ANTIFERROMAGNETISM. Ô.Nagai.
Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 4, 129-35 (Jan., 1958).

The ground state of antiferromagnetism is investigated by Marshall's method (Abstr. 9757/1955). The magnetization of sublattice as a function of a (an anisotropic parameter), and especially the critical value of a at which the antiferromagnetic ordering disappears, are computed. The number of antiparallel pairs is also calculated. Various treatments, including Marshall's method, are examined. The approximate method of Slater is extended to two and three-dimensional lattices.

538.122.08 : 539.14

1581. A FREE NUCLEAR INDUCTION METHOD OF MEASUREMENT OF WEAK MAGNETIC FIELDS.
A.V.Mel'nikov, A.A.Morozov, A.Ya.Rotshteĭn, F.I.Skripov and S.V.Smirnov.
Zh. tekh. Fiz., Vol. 28, No. 4, 910-12 (1958). In Russian.
A brief description is given of a laboratory apparatus which was developed and tested for measuring weak magnetic fields.

538.22 : 548.736.4

1582. SOME MAGNETIC AND CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $Li_x^+Ni_{1-2x}^{++}Ni_x^{+++}O$.
J.B.Goodenough, D.G.Wickham and W.J.Croft.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 107-16 (1958).
Crystallographic and magnetic measurements of the system $Li_x^+Ni_{1-2x}^{++}Ni_x^{+++}O$ for the entire range $0 \leq x \leq 0.5$ are reported. For values of $x \leq 0.3$, the lattice appears to be antiferromagnetic and is cubic above the Curie temperature. For the range of composition $0.3 < x < 0.5$, the lattice is rhombohedral and ferrimagnetic, a maximum magnetic moment per gram of 31 c.g.s. $cm^3/g$ being observed at $x = 0.46$. A maximum ferrimagnetic Curie temperature of 241°K was observed for the composition $x = 0.41$. These properties are interpreted in terms of a partial ordering of lithium and nickel ions into alternative sets of (111) planes which couple antiparallel to one another, the moments within any set being either ferromagnetically coupled or paramagnetic, depending upon the number of non-magnetic near neighbours in the neighbouring planes. This system is compared with the ordered rock-salt-type compound $Cu_{0.25}Co_{0.75}O$. The lack of ferrimagnetism and the tetragonal distortion to $c/a < 1$ in $Cu_{0.25}Co_{0.75}O$ are explained.

538.22 : 537.312.62

SUSCEPTIBILITY, AND NUCLEAR MAGNETIC RESONANCE IN FINELY DIVIDED SUPERCONDUCTORS. See Abstr. 1481

538.221 : 553

1583. ON THE UTILIZATION OF MEASUREMENTS ON FERROMAGNETIC MINERALS. W.Gerlach and J.Kranz.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 280-2 (1957). In German.
Describes a procedure for determining the specific magnetization and the concentration of ferromagnetic particles in a non-magnetic matrix. A.E.De Barr

538.221

1584. SPONTANEOUS MAGNETIZATION OF A THIN FILM MEASURED BY ELECTRON DIFFRACTION. S.Yamaguchi.
Canad. J. Phys., Vol. 36, No. 9, 1251 (Sept., 1958).
A diffraction pattern obtained for a gold film was superposed on that for a film containing nickel and nickel oxide. The two patterns were not concentric and from the relative displacement a value for the magnetization of the film was obtained.
D.J.Oliver

538.221

1585. EFFECT OF SAMPLE THICKNESS ON THE FIELD ANNEALING OF 6.5% Si–Fe. P.A.Albert.
J. appl. Phys., Vol. 29, No. 3, 351-2 (March, 1958).
Iron alloys containing about 6.5 weight per cent silicon are known to respond to heat treatment in a magnetic field. Since the degree of response has been observed to vary with sheet thickness, a study was made to better define this variation. Two different alloy compositions were cast in cylindrical moulds. The ingots were drilled to form hollow cylinders which were sliced and polished to rings of final thicknesses of from 0.150 in. to 0.0025 in. D.C. hysteresis loops were measured on samples as annealed 2 hr at 1000°C in dry hydrogen, and as subsequently cooled at 40 deg C/hr from 900°C in a circumferential magnetic field of 10 Oe. The differences in coercive force and maximum permeability between samples field annealed and not field annealed are thickness dependent, and are greater for thicker samples. The effects of thickness on coercive force are lessened by electropolishing, which greatly reduces the slope of the $H_C$ v. (1/d) curve for both the field-annealed and not field-annealed states. The maximum permeability is not found to be affected by electropolishing.

538.221 : 539.219

1586. RELATION OF MAGNETIC DISORDERING TO THE THERMODYNAMICS OF SOLID METALLIC SOLUTIONS. R.A.Oriani.
J. chem. Phys., Vol. 29, No. 3, 679 (Sept., 1958).
It is argued that at 1110°K the face-centred solid solutions of iron–nickel at concentrations from 0 to 56 atomic % Ni have an excess entropy close to zero, which means that the magnetic moments of the iron and nickel atoms are not changed by the solution process. This behaviour is contrasted with that of Au–Ni alloy.
W.Good

538.221

1587. REVERSIBLE PERMEABILITY AND LOSSES IN MAGNETICALLY ANNEALED PERMINVAR.
E.W.Lee and A.G.H.Troughton.
Proc. Phys. Soc., Vol. 72, Pt 4, 596-603 (Oct., 1958).
Measurements are reported of reversible permeability and associated losses for a specimen of magnetically annealed Perminvar possessing a rectangular B–H loop. Measurements were recorded both as the hysteresis cycle was traversed and when a circular domain was nucleated and pushed into the centre of the specimen using a small pulsed field. Under these conditions the observed eddy current losses were twelve times those calculated from a uniform permeability model. A tentative explanation of the nature of the restoring force on the circular wall is given.

538.221 : 539.32

1588. THE INTERPRETATION OF MAGNETIC SUSCEPTIBILITY AND THE ΔE EFFECT IN TERMS OF DOMAIN PROCESSES.
B.Lewis and R.Street.
Proc. Phys. Soc., Vol. 72, Pt 4, 604-17 (Oct., 1958).
General formulae applicable to any model or any domain process are derived for the magnetic susceptibility $\chi$ and the magnetically dependent part of Young's modulus $\Delta E$. From these formulae expressions are obtained for $\chi$ and $\Delta E$ in the initial magnetization regions for domain assemblies where magnetization proceeds by (a) rotation of domain magnetization vectors against internal strain anisotropy, (b) rotation against magnetocrystalline anisotropy characterized by one, three or four preferred axes and (c) simple movement of 90° and 180° boundary walls. It is then shown how the types and relative importance of the domain processes operative in the initial magnetization region may be determined from measurements of $\chi$ and $\Delta E$. Examples of this procedure are given and include the case of annealed cobalt for which the $\Delta E$ effect is due entirely to rotations against uniaxial magnetocrystalline anisotropy energy, while the susceptibility arises mainly from 180° boundary wall movement. For annealed nickel, experimental values of $\Delta E$ and $\chi$ obtained by a number of workers vary widely and this is shown to be due to (i) differences in the relative proportions of 90° and 180° boundaries and (ii) the influence of the annealing process on the ease of boundary wall movement.

538.221

1589. FERROMAGNETIC RESONANCE ABSORPTION IN PERMENORM AT 1.64 cm WAVELENGTH. P.Hedvig.
Acta phys. Hungar., Vol. 8, No. 4, 437-9 (1958).
Absorption curves for a disk-shaped, strongly deformed, single crystal of Permenorm are presented for 6 directions of external magnetic field in the plane of the disk. A.J.Manuel

538.221 : 548.736.4 : 539.219

MAGNETIC STUDIES ON IRON–ALUMINIUM ALLOYS. See Abstr. 855

538.221 : 539.32

ACOUSTIC RELAXATIONS IN FERRITE SINGLE CRYSTALS. See Abstr. 872

538.221 : 548.23

ORIENTATION STUDY OF ULTRA-THIN MOLYBDENUM PERMALLOY TAPE. See Abstr. 916

538.221 : 537.311.31

MAGNETIC SUSCEPTIBILITIES OF SOME URANIUM ALLOYS. See Abstr. 1431

538.222 : 539.14

1590. ORIGIN OF NUCLEAR MAGNETIC RESONANCE SHIFTS IN PARAMAGNETIC $MnF_3$. R.G.Shulman and V.Jaccarino.
Phys. Rev., Vol. 109, No. 4, 1084-5 (Feb. 15, 1958).
The nuclear magnetic resonance of $F^{19}$ in $MnF_3$ was observed and shifts from the normal resonance field of several percent were measured. The shifts are paramagnetic, and it is shown that the mechanism of electron transfer cannot account for a shift in this direction. However, the results could be explained by covalent bonding between fluorine and manganese.

538.222 : 539.1.07

MAGNETIC RESONANCE SPECTROMETER. See Abstr. 508

538.222 : 539.14 : 539.1.07

A SIMPLE ARRANGEMENT FOR STUDYING DOUBLE MAGNETIC RESONANCES, AND AN APPLICATION TO CARBON.
See Abstr. 510

538.222 : 537.311.31 : 539.219

MAGNETIC SUSCEPTIBILITY OF $\gamma$-URANIUM ALLOYS.
See Abstr. 858

# ELECTROMAGNETISM
# MAGNETOHYDRODYNAMICS

538.3

1591. ELECTROMAGNETIC EQUATIONS WRITTEN IN A FORM INDEPENDENT OF THE SYSTEM OF UNITS. D.W.Berreman.
Amer. J. Phys., Vol. 27, No. 1, 44-6 (Jan., 1959).

This paper illustrates a form for writing electromagnetic equations such that by substituting the appropriate value for each of two arbitrary constants one immediately obtains the electromagnetic equations written in any of the consistent systems of units. One constant is a dimensionless term called a rationalizing factor that takes the value $4\pi$ in unrationalized systems and unity in rationalized systems. The other is $\epsilon_0$, the capacitivity of free space. Except for the rationalizing factor, all equations are identical in appearance with equations written in the rationalized M.K.S.Q. system of units. Maxwell's equations and some other commonly used relations are presented in this form. A simple method of obtaining the equations in the Gaussian and the Heaviside–Lorentz mixed systems of units from the form presented for consistent systems is also given.

538.3

1592. AN AXIOMATIZATION OF MAXWELL'S THEORY OF THE ELECTROMAGNETIC FIELD. J.I.Horváth.
Acta phys. Hungar., Vol. 8, No. 4, 399-418 (1958). In German.

An attempt is made to present the experimental basis of Maxwell's theory in axiomatic form. W.A.Hepner

538.3

1593. ON THE EQUATION OF THE ELECTROMAGNETIC MOMENTUM IN THE ELECTRODYNAMICS OF MOVING BODIES. G.Carini.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 4, 283-91 (1955-56). In Italian.

Starting from Minkowski's electromagnetic equations for moving bodies, the expression for the electromagnetic momentum is deduced from the energy theorem and from the principle of (special) relativity. P.Roman

538.3 : 537.21

1594. ELECTRODIELECTRIC INDUCTION. P.de Belatini.
Bull. Tech. Univ. Istanbul, Vol. 10, No. 1, 84-111 (1957).

Continuing the work presented in a previous paper (Abstr. 7099/1954), the author dwells on analogies between magnetic and dielectric quantities and laws, and formulates, in particular, the law of "electrodielectric induction". The underlying idea is to introduce the concept of a dielectric circuit in analogy to the magnetic circuit. P.Roman

538.3

1595. ON THE POSSIBLE EXISTENCE OF CONSERVATIVE SYSTEMS OF ELECTRIC CHARGES WITH NON-STATIONARY FIELDS IN THE CLASSICAL THEORY OF ELECTRODYNAMICS. J.Bomze.
S.B. Osterr. Akad. Wiss. mat.-nat. Kl. Abt. II, Vol. 165, No. 8-10, 313-25 (1956). In German.

It is shown that the mathematical description of an electrodynamic system in which the field varies in time, but does not radiate energy, must contain both the retarded potential solution and the advanced potential solution. The arguments which have been used for regarding the advanced potential solution as physically impossible are criticized. P.M.Davidson

538.3

1596. ELEMENTARY ELECTRIC WAVES. I. A CONTRIBUTION TO THE KINEMATICS OF ELEMENTARY ELECTRIC CHARGES. J.Bomze.
S.B. Österr. Akad. Wiss. mat.-nat. Kl. Abt. II, Vol. 166, No. 6-10, 77-109 (1957). In German.

The investigation is based on Flamm's line-mechanics of the electromagnetic field. The differential equations for the lines of force associated with a moving charge are derived, and are integrated for the case of motion in a plane. R.A.Newing

538.3 : 532.5

1597. ON SOME MAGNETOHYDRODYNAMICAL MOTIONS OF COSMOLOGICAL INTEREST IN A ROTATING CYLINDRICAL FLUID MASS. C.Agostinelli.
Atti Accad. Sci. Torino I, Vol. 90, No. 2, 479-508 (1955-56). In Italian.

The magnetic intensity and fluid velocity components for a uniform conducting liquid are expressed in terms of two scalar functions V and W which do not involve the axial coordinate z. V and W are expressed in the form

$$V = -\tfrac{1}{2}h_0 r^2 + \Psi(r, \phi, t),$$

$$W = -\tfrac{1}{2}\omega r^2 + \alpha\Psi(r, \phi, t),$$

where $\omega$ is angular velocity about the z-axis, and $h_0$ and $\alpha$ are constants. General solutions are obtained for the following cases (1) $\Delta_2\Psi = 0$ with $\alpha$ arbitrary; (2) $\alpha^2 = \mu/4\pi\rho$; (3) $\Delta_2\Psi = k\Psi$. It is suggested that the solutions obtained may have applications in the theory of the structure of spiral nebulae. R.A.Newing

538.3 : 532.5

1598. THE STABILITY OF COUETTE FLOW IN AN AXIAL MAGNETIC FIELD. E.R.Niblett.
Canad. J. Phys., Vol. 36, No. 11, 1509-25 (Nov., 1958).

Chandrasekhar's theory of the stability of viscous flow of an electrically conducting fluid between coaxial rotating cylinders with perfectly conducting walls is extended to include the case of non-conducting walls, and it is found that their effect is to reduce the critical Taylor numbers and increase the wavelength of the instability patterns by considerable amounts. An experiment designed to measure the values of magnetic field and rotation speed at the onset of instability in mercury between perspex cylinders is described. The radioactive isotopes $Hg^{197}$ and $Hg^{203}$ were used to trace the flow. The results support the theoretical prediction that the boundary conditions can have a large effect on the motion.

538.3 : 532.5

1599. ON HYDROMAGNETIC EQUILIBRIUM. L.Woltjer.
Proc. Nat. Acad. Sci. U.S.A., Vol. 44, No. 9, 833-41 (Sept., 1958).

It is shown that, in the absence of external fields and dissipative processes, the hydromagnetic equations admit six integrals in addition to the energy integral; one integral corresponds to the fact that the parallel components of the magnetic and velocity fields do not interact, and others express conservation of angular momentum and mass. Equations for stable dynamical equilibrium are obtained by minimizing the total energy, keeping constant the other six integrals of motion. It is concluded that in general non-force-free solutions involve non-zero velocity fields. R.A.Newing

538.3 : 532.5

1600. ON THE EQUILIBRIUM CONFIGURATIONS OF AN INCOMPRESSIBLE FLUID WITH AXISYMMETRIC MOTIONS AND MAGNETIC FIELDS. S.Chandrasekhar.
Proc. Nat. Acad. Sci. U.S.A., Vol. 44, No. 9, 842-7 (Sept., 1958).

Seven integrals of the equations of motion are established, three of which have no analogues in the non-axisymmetric case, and Woltjer's variational method is used to discuss possible equilibrium configurations. The restriction to axisymmetry leads to an enlargement of the class of equilibrium states, but it is concluded that states dependent on the three integrals characteristic of axisymmetry are not likely to have practically realizable counterparts. R.A.Newing

538.3 : 532.5

1601. SOME STABLE HYDROMAGNETIC EQUILIBRIA. J.L.Johnson, C.R.Oberman, R.M.Kulsrud and E.A.Frieman.
Phys. of Fluids, Vol. 1, No. 4, 281-96 (July-Aug., 1958).

These equilibria are obtained for a variety of situations which differ little from that of a zero pressure uniform axial magnetic field. Criteria for ascertaining the stability of these equilibria are found by means of an energy principle. In particular, if helically invariant fields are present, stable equilibria with non-zero pressure and net axial current can be found.

538.3 : 532.5

1602. SOME EXACT SOLUTIONS OF THE EQUATIONS OF MAGNETOHYDRODYNAMICS WHEN BOTH SELF-ATTRACTION AND MAGNETIC FIELDS ARE PRESENT. G.C.McVittie.
Rev. mod. Phys., Vol. 30, No. 3, 1080-2 (July, 1958).

In the first type of solution, which contains one arbitrary function, an infinite slab of gas moves with velocity proportional to t but independent of position. The current and density are proportional, vanishing at both faces. In the second type of solution, which also contains one arbitrary function, an infinite cylinder expands and contracts radially with velocity proportional to r at constant t. Oscillatory solutions are given for which the density, pressure, and magnetic field vanish at the surface of the cylinder.

O.Penrose

538.3 : 532.5

1603. DISTORTION OF A TOROIDAL FIELD BY CONVECTION. D.W.Allan and E.C.Bullard.
Rev. mod. Phys., Vol. 30, No. 3, 1087 (July, 1958).

The effect of convective motions on an initially toroidal (i.e. horizontal) field near the surface of a fluid of finite conductivity has been studied in some simple cases by an approximate analytical method. It is found that the time to reach equilibrium is very long indeed, but apparently a loop of field is pushed outside the fluid fairly quickly. The result gives a possible explanation of the large changes observed in sunspot and terrestrial fields. O.Penrose

538.3 : 532.5

1604. AERODYNAMIC DISSIPATION. H.E.Petschek.
Rev. mod. Phys., Vol. 30, No. 3, 966-72 (July, 1958).

Flow situations in an ionized gas are classified according to the relative sizes of $\lambda$ the mean free path, $r_i$ and $r_e$ the ion and electron Larmor radii, and $l$ the scale length. There are four basic situations: $\lambda < r_e < r_i < l$ (S region, where normal magnetohydrodynamics applies), $r_e < \lambda < r_i < l$ (T region), $r_i < \lambda$ and $r_i < l$ (M region, where magnetic forces dominate), and $l < r_i$ (EM region). Interstellar gas clouds and the solar corona are M-region. The M-region phenomena analogous to shock waves are treated here, using Boltzmann's equation. First it is shown that the front of a broad pressure pulse will steepen until its thickness is comparable with $r_i$ (not $\lambda$) or even less. A possible illustration of this is the sudden commencement of terrestrial magnetic storms. Next, a method of treating the steady-state structure of a weak shock is outlined, with the conclusion that a pulse, roughly $r_i$ in width, is apparently the only possible solution. The nearest analogue of a true shock wave appears to be a train of such pulses. AVCO experiments on M-region gas dynamics are described briefly.

O.Penrose

538.3 : 532.5 : 537.56

1605. AXIALLY SYMMETRIC SOLUTIONS OF THE MAGNETOHYDROSTATIC EQUATION WITH SURFACE CURRENTS. L.Biermann, K.Hain, K.Jörgens and R.Lüst.
Z. Naturforsch., Vol. 12a, No. 10, 826-32 (1957). In German.

Solutions are derived for a plasma contained in a torus of circular cross-section, the electric current flow being confined to the surface. The magnetic field intensity is determined for given surface currents. It is shown that the currents must possess azimuthal components. R.A.Newing

538.3 : 532.5

1606. AXIAL-SYMMETRIC MAGNETOHYDRODYNAMIC STABILITY CONFIGURATIONS. R.Lüst and A.Schlüter.
Z. Naturforsch., Vol. 12a, No. 10, 850-4 (1957). In German.

It is shown that in equilibrium the gas pressure p and the toroidal part T of the magnetic field must be functions of the meridional part F. Assuming the forms of these functions, a differential equation for F is derived and solved, assuming that T(F) is constant. The magnetic lines of force are then calculated numerically and sketched for a special case. Some remarks on the stability are added. W.A.Hepner

538.3 : 532.5 : 537.56

1607. ON THE STABILITY OF A PLASMA. K.Hain, R.Lüst and A.Schlüter.
Z. Naturforsch., Vol. 12a, No. 10, 833-41 (1957). In German.

It is shown that, neglecting viscosity, resistivity and thermal conductivity, motion in the neighbourhood of equilibrium is governed by a self adjoint differential equation of the second order. Some general theorems are established and some sufficient conditions for stability are given. R.A.Newing

538.3 : 532.5 : 534.2

1608. ON THE THEORY OF EXCITATION OF HYDROMAGNETIC WAVES. A.I.Akhiezer and A.G.Sitenko.
Zh. eksper. teor. Fiz., Vol. 35, No. 1(7), 116-20 (1958). In Russian.

Excitation of hydromagnetic and magnetoacoustic waves by external currents is investigated. Damping of the waves due to the conductivity and viscosity of the medium is taken into account. Excitation by currents is compared with excitation by mechanical means with respect to intensity.

538.3 : 532.5

1609. ONE-DIMENSIONAL MOTION IN MAGNETOHYDRODYNAMICS. G.S.Golitsyn.
Zh. eksper. teor. Fiz., Vol. 35, No. 3(9), 776-81 (1958). In Russian.

The motion of a perfect conducting gas in a magnetic field is investigated. The Riemann invariants for a number of gases are computed and some non-stationary problems are solved. A new method is proposed for determining the approximate general solution of the magnetohydrodynamic equations. Some types of motion in the presence of shock waves are considered.

538.3 : 532.5 : 550.38

THE MAGNETIC FIELD AND THE CENTRAL CORE OF THE EARTH. See Abstr. 935

538.3 : 532.5 : 551.510.535

A DYNAMIC THEORY OF THE IONOSPHERE. See Abstr. 947

538.3 : 532.5 : 523.16

POSSIBLE HYDROMAGNETIC SIMULATION OF COSMICAL PHENOMENA IN THE LABORATORY. See Abstr. 987

538.3 : 532.5 : 523.161

SHOCK WAVES IN MAGNETOGASODYNAMIC TURBULENCE. See Abstr. 993

538.3 : 532.5 : 537.56

EQUILIBRIUM OF A MAGNETICALLY CONFINED PLASMA IN A TOROID. See Abstr. 1554

538.31

1610. THE AMPLIFICATION OF A MAGNETIC FIELD BY A HIGH CURRENT DISCHARGE. R.J.Bickerton.
Proc. Phys. Soc., Vol. 72, Pt 4, 618-24 (Oct., 1958).

A discharge in a longitudinal magnetic field in which the plasma pressure is balanced by electrodynamic forces is considered. It is shown that the resulting current flow is helical about the axis of the discharge. The direction of the helix is such that the initial longitudinal field is amplified inside the discharge channel. Some experimental evidence supporting the theory is presented.

# ELECTROMAGNETIC WAVES AND OSCILLATIONS

538.5 : 532.570.8

ELECTROMAGNETIC FLOWMETER THEORY. See Abstr. 1138

538.56 : 535.13 : 534.23 : 530.19

TOROIDAL WAVE FUNCTIONS. See Abstr. 1112

538.566 : 621.372.8

1611. THE LAUNCHING OF A TRANSVERSE MAGNETIC SURFACE WAVE ON A DIELECTRIC CYLINDER. C.Jauquet.
Bull. Acad. Roy. Belgique Cl. Sci., Vol. 42, No. 7, 802-12 (1956). In French.

A theoretical investigation of the junction between a coaxial line whose outer conductor terminates in an infinite conducting plane and a dielectric cylinder which joins to the inner conductor in the same plane. Surface waves have been efficiently launched by this method. The theoretical model treated is one in which the inner of the coaxial line is replaced by an infinitely thin current annulus in the junction plane, of radius equal to that of the inner (and of the dielectric rod). The equations are then formulated in terms of an appropriate delta function and are solved by contour integration.

G.D.Sims

538.566 : 537.521

1612. SCATTERING OF MICROWAVE RADIATION BY A PLASMA COLUMN. F.I.Boley.
Nature (London), Vol. 182, 790-1 (Sept. 20, 1958).

Pronounced microwave scattering occurs from the positive column of a mercury discharge tube at several distinct currents. The variation of these resonance peaks with scattering angle was measured and for each peak was found to be consistent with dipole scattering. D.Walsh

538.566 : 535.43

1613. VARIATIONAL PRINCIPLES IN HIGH-FREQUENCY SCATTERING. R.D.Kodis.
Proc. Cambridge Phil. Soc., Vol. 54, Pt 4, 512-29 (Oct., 1958).

A pair of variational principles are formulated for two-dimensional scattering by obstacles. The first of these is in terms of the obstacle boundary values, and it is shown that a simple "optical" trial function leads to an incorrect frequency dependence for the scattering cross-section. In the second, the obstacle is viewed as the analogue of an aperture coupling two half spaces. The geometric optics part of the cross-section can then be made explicit and is split off to leave a stationary form for the frequency correction. The zero-order calculation for the cross-section of a circle, using corresponding "optical" trial functions, is found to have the correct $(ka)^{-\frac{2}{3}}$ frequency dependence.

538.566

1614. ON THE GREEN FUNCTION FOR A TRANSPARENT CYLINDER. P.Beckmann and W.Franz.
Z. Naturforsch., Vol. 12a, No. 3, 257-67 (1957). In German.

Previous work (Abstr. 2023/1955) is modified for the case of diffraction by a transparent cylinder. The Green function is expressed as a series of complex integrals which correspond to the various types of waves associated with the problem, and which are suitable for numerical evaluation. R.A.Newing

538.566

1615. APPROXIMATE COMPUTATION OF THE DIFFRACTION OF PLANE ELECTROMAGNETIC WAVES AT CERTAIN METAL BODIES. I. DIFFRACTION PATTERNS AT A WEDGE AND A RIBBON. P.Ya.Ufimtsev.
Zh. tekh. Fiz., Vol. 27, No. 8, 1840-9 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1708-18 (Aug., 1957).

A new method is developed for the approximate computation of the scattering at certain ideally-conducting convex bodies whose surfaces have bends. This method is applicable for wavelengths that are much smaller than the linear dimensions of the bodies; it is also applicable at a sufficiently large distance from the bodies.

538.566

1616. THE DIFFRACTION OF ELECTROMAGNETIC WAVES AT INFINITELY THIN, IDEALLY CONDUCTING PLANE SCREENS. G.A.Grinberg and Yu.V.Pimenov.
Zh. tekh. Fiz., Vol. 27, No. 10, 2326-39 (1957). In Russian.

A new method is proposed for solving problems of the diffraction of electromagnetic waves at infinitely thin, ideally conducting screens. The method is based on a reduction of the problem to a solution of two independent, structurally simple integral equations. It is also shown that for sufficiently small values of kl, where l is a length characterizing the dimensions of the screen, the solution of the diffraction problem considered is reduced to the solution of a number of consecutive electrostatic problems. The diffraction at an infinitely thin, ideally conducting disk is treated as an example.

538.566

1617. A METHOD OF SOLVING THE PROBLEMS OF THE DIFFRACTION OF ELECTROMAGNETIC WAVES AT IDEALLY CONDUCTING PLANE SCREENS, BASED ON A STUDY OF SHADOW CURRENTS INDUCED ON THE SCREENS. I. GENERAL PRINCIPLES OF THE METHOD. G.A.Grinberg.
Zh. tekh. Fiz., Vol. 28, No. 3, 542-54 (1958). In Russian.

The method is based on a consideration of the currents produced by the action of the external field on the shadow sides of the screens ("shadow currents"). It is shown that in the case of any three-dimensional external fields, the problem can be reduced to solving a system of two integral equations, relatively simple in structure, for the Cartesian components of the density of currents induced on the screens. A study of the current distribution on the shadow sides of the screens is particularly expedient when the wavelength of the incident radiation is small in comparison with the screen dimensions.

538.566

1618. A METHOD OF SOLVING THE PROBLEMS OF THE DIFFRACTION OF ELECTROMAGNETIC WAVES AT IDEALLY CONDUCTING PLANE SCREENS, BASED ON A STUDY OF SHADOW CURRENT INDUCED ON THE SCREENS. II. DIFFRACTION AT A SEMIPLANE AND AT A PLANE WITH AN INFINITE RECTILINEAR SLIT. G.A.Grinberg.
Zh. tekh. Fiz., Vol. 28, No. 3, 555-68 (1958). In Russian.

The method of shadow currents, developed in Pt I (see preceding abstract), is applied to the solution of diffraction at a semiplane and at a plane with an infinite rectilinear slit. In the first case, general expressions are derived for the currents induced on the screen. In the second case, the problem reduces to the solution of two independent integrals of Fredholm equations of the second order.

538.566

1619. SECONDARY DIFFRACTION OF ELECTROMAGNETIC WAVES AT A STRIP. P.Ya.Ufimtsev.
Zh. tekh. Fiz., Vol. 28, No. 3, 569-82 (1958). In Russian.

A previously developed approximate method of solving diffraction problems is improved, taking into account the so-called effect of secondary diffraction, i.e. the interaction of currents flowing in different elements of the surface of the body. In the case of diffraction at a strip this interaction is a maximum for directions of observation close to the plane of the strip as well as for grazing incidence of the

538.566

1620. THE PROPAGATION OF SLOW ELECTROMAGNETIC WAVES ALONG INHOMOGENEOUS PLASMA LAYERS. W.Oehrl.
Z. angew. Phys., Vol. 9, No. 4, 164-71 (April, 1957). In German.

A theoretical examination based on a model in which an inhomogeneous plasma zone having a linear increase in concentration lies between a homogeneous plasma zone and air.

C.G.Morgan

538.566.2

1621. ON THE WAVE EQUATION OF G.LAMPARIELLO FOR MOVING BODIES. C.Totaro.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 4, 293-8 (1955-56). In Italian.

The general solutions of Lampariello's electromagnetic wave equation (Abstr. 4808-9/1955) are found and physically interpreted. The initial value problem of Cauchy is also investigated.

P.Roman

538.566.2

1622. PROPAGATION OF AN ELECTROMAGNETIC PULSE IN A MEDIUM HAVING DIELECTRIC LOSSES. M.Cotte.
C.R. Acad. Sci. (Paris), Vol. 247, No. 17, 1324-7 (Oct. 27, 1958). In French.

A medium which has dielectric losses may be regarded as having a dielectric constant which is a complex quantity, of magnitude depending on the frequency of the individual waves into which a disturbance may be resolved. Expressions for the propagation of a disturbance are derived and their practical applications are discussed. P.M.Davidson

538.566.2

1623. PROPAGATION OF TRANSIENT ELECTROMAGNETIC WAVES IN A MEDIUM OF FINITE CONDUCTIVITY. B.K.Bhattacharyya.
Geophysics, Vol. 22, No. 1, 75-88 (Jan., 1957).

Transient electric and magnetic fields were calculated for ramp function and sawtooth current sources immersed in a semiconducting medium. An electric dipole source is assumed. In the case of a ramp-function input, it is observed that the peaks of the overshoots in the $\theta$-component of the electric field decrease in magnitude with the increase in rise-time of the input pulse. It is also shown that the rise-time of the current pulses has a definite effect upon the rise time and amplitude of the electric fields and that the sawtooth exciting pulses having large values of rise-time may be conveniently used to obtain measurable values of the electric and magnetic fields.

538.566.2

1624. VARIATIONAL PRINCIPLES FOR GUIDED ELECTROMAGNETIC WAVES IN ANISOTROPIC MATERIALS. W.Hauser.
Quart. appl. Math., Vol. 16, No. 3, 259-72 (Oct., 1958).

A general method is developed for obtaining approximate solutions to the problems of the propagation of waves in a guide which may only be partially filled with material having tensor electromagnetic properties. With the introduction of an appropriate dyadic Green's function, one is able to obtain a formal solution to the problem in terms of an integral involving the field vectors in the perturbing rod. The reformulation of the original problem in terms of an integral equation enables one to construct a variational principle whose extremal value is insensitive to a great range of trial functions. The extremal value of the variational expression from which the integral equations for the field are derivable is shown to be proportional to $(\gamma_0^2 - \gamma^2)$, the difference between the square of the propagation constant of the wave in the empty and loaded guide. Normal modes in terms of which an expansion of the dyadic Green's function is obtained are defined. In the last section

the ability is demonstrated of the variational method to improve the results obtained by perturbation methods obtaining a first order approximation for the propagation constant of a wave in a rectangular guide containing an infinite ferrite slab.

538.566.2

1625. PROPAGATION OF ELECTROMAGNETIC WAVES IN A MEDIUM, TAKING ACCOUNT OF SPATIAL DISPERSION. V.M.Agranovich and A.A.Rukhadze.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 982-4 (1958). In Russian.

A method is presented for investigating electromagnetic waves in a medium with spatial dispersion. Expansions of the "direct" and "inverse" spatial dispersions are obtained.

538.566.2

1626. ON ELECTROMAGNETIC WAVES IN MOVING CONDUCTORS. G.Crupi.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 2, No. 4, 299-307 (1955-56). In Italian.

The velocity of wave propagation, the absorption coefficient and the refractive index are calculated, using the wave equation as given by Carini. See also Abstr. 6313 (1955). P.Roman

538.566.2

1627. ON PULSED ELECTROMAGNETIC WAVES IN MOVING BODIES. G.Crupi.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 3, No. 1, 73-87 (1956-57). In Italian.

The problem is treated by an application of Lampariello's equation (see Abstr. 4809/1955) for the case of a rectangular pulse generated at z = 0 and propagating as two plane waves in opposite directions. The medium is also supposed to be in motion along z and formulae are deduced showing how the velocity of propagation and the amplitude of the progressive and regressive wave (which are no longer equal) depend on the velocity of the dielectric.

L.Pincherle

538.566.2

1628. THE PHENOMENA OF REFLECTION AND REFRACTION IN MOVING BODIES. C.Totaro.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 3, No. 1, 89-94 (1956-57). In Italian.

A constant velocity is considered, and the generalization of Fresnel's equations is obtained by means of simple considerations, without a direct application of the Lorentz transformation.

L.Pincherle

538.566.2

1629. PROPAGATION OF AN ELECTROMAGNETIC FIELD IN A MEDIUM WITH SPATIAL DISPERSION. V.D.Shafranov.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1475-89 (1958). In Russian.

General formulae are obtained for an electromagnetic field in a semi-infinite homogeneous anisotropic medium with spatial dispersion. Propagation of a transverse wave along a magnetic field in a plasma is investigated taking into account thermal motion of the electrons. It is pointed out that absorption of electromagnetic waves is strong in the region in which Cherenkov radiation occurs in the plasma.

538.566.2 : 539.2

1630. ON ELECTROMAGNETIC WAVES IN ISOTROPIC AND CRYSTALLINE MEDIA TAKING INTO ACCOUNT SPATIAL DISPERSION OF THE DIELECTRIC PERMITTIVITY. V.L.Ginzburg.
Zh. eksper.teor. Fiz., Vol. 34, No. 6, 1593-604 (1958). In Russian.

The tensor of dielectric permittivity $\epsilon_{ik}$ is usually considered to be a function of only the frequency. Thus the spatial dispersion, that is, the dependence of $\epsilon_{ik}$ on wavelength is neglected. However, even for a non-gyrotropic medium spatial dispersion should be taken into account in the case of sufficiently small absorption in the region in which the refractive index rapidly increases and tends to infinity, if dispersion and absorption are neglected. Account of spatial dispersion is also important in the analysis of longitudinal (plasma) waves which are propagated in an isotropic medium or along the principal dielectric axes in crystals. Spatial dispersion, moreover, leads to weak optical anisotropy in cubic crystals. Besides the topics mentioned above the problem of collective (discrete) energy losses of electrons in solids is also discussed.

538.566.2

1631. ON DETERMINATION OF MAGNETIC AND ELECTRIC FIELDS IN THIN FILMS AND SHELLS. L.A.Tseĭtlin.
Zh. tekh. Fiz., Vol. 28, No. 6, 1326-9 (1958). In Russian.

Propagation of electromagnetic waves in a medium containing magnetic or dielectric films or shells is considered theoretically.

538.566.3 : 621.396.8

1632. RADIO ABSORPTION BY THE LOWER IONOSPHERE, MEASURED IN A ROCKET. H.Mende, K.Rawer and E.Vassy.
Ann. Geophys., Vol. 13, No. 3, 231-3 (1957). In French.

Field-strength measurements of commercial broadcasting stations were made in a rocket flight which reached a maximum altitude of 104 km. D-layer absorption was detected from 70 km, with a maximum near 80 km for medium-wave reception (stations distant 400-500 km; frequencies 600-700 kc/s). Results for the long-wave (200 kc/s) station used are difficult to interpret because its distance was such that it was not in optical range of the rocket.

G.M.Brown

538.566.3 : 551.594.6

1633. POLARIZATION OF ATMOSPHERIC PULSES DUE TO SUCCESSIVE REFLECTIONS FROM THE IONOSPHERE. B.A.P.Tantry and R.S.Srivastava.
J. geophys. Res., Vol. 63, No. 3, 527-38 (Sept., 1958).

In determining the direction of arrival of atmospherics by using a "crossed"-loop cathode-ray direction-finder, it was found that, on occasions, in addition to the usual straight-line responses on the oscillographic screen, there were elliptic patterns of gradually decreasing eccentricity, size, and tilt-angle. The observed elliptic patterns are considered as due to the abnormal polarization of the atmospheric pulses reflected successively from the ionosphere, while the linear responses are due to the direct atmospheric pulses. It is shown how from the observed polarization ellipses and the orientation of the linear response, the polarization characteristics of the atmospheric pulses reflected successively from the ionosphere can be determined. On analysing the observed patterns, it is found that, in general, the phase-difference between the normal and abnormal components increases gradually with the increasing order of reflection., It is suggested that the observed straight lines in the D/F pattern, bunched within a small angle, are due to the radiation pulses originating at the branching points of a long horizontal or slightly inclined lightning channel from one cloud to another. The approximate calculation from the observed angular width of the bunch of straight lines has shown that the horizontal length of the channel is consistent with Shipley's observations of horizontal lighting channels along the lower edge of a cloud.

# NUCLEAR AND ATOMIC PHYSICS

539.1

1634. HIGH ENERGY NUCLEAR PHYSICS. G.H.Stafford.
Nature (London), Vol. 182, 356-8 (Aug. 9, 1958).

The international conference on high-energy nuclear physics reported here was held in Geneva from 30th June to 5th July, 1958. It was sponsored by the I.U.P.A.P. and was the successor to the Rochester Conferences. Reports were given on experimental and theoretical aspects of nuclear structure (particularly as revealed by high-energy electron scattering), K-mesons and hyperons, weak interactions (with particular emphasis of parity non-conservation) and the interaction of nucleons with pions, photons, nucleons and antinucleons. A.E.I. Research Laboratory

539.1 : 53.081

1635. CHANGES IN THE 1955 ATOMIC CONSTANTS OCCASIONED BY REVISION OF $\mu_e/\mu_o$.
E.R.Cohen and J.W.M.DuMond.
Phys. Rev. Letters, Vol. 1, No. 8, 291-2 (Oct. 15, 1958).

This ratio, of the magnetic moment of the electron to the Bohr magneton, has to be revised because of the discovery of an error in the theoretical formula of Karplus and Kroll (1951). The ratio has to be increased by 14.3 parts per million, and this causes the following changes, in parts per million, in the 1955 constants: e, −27.0; m, −12.1; h, −40.0; $\alpha$, −14.0; $\lambda_g/\lambda_s$, −7.6; N, 26.3; F, −1.0.

J.Hawgood

# APPARATUS . PARTICLE DETECTORS

539.1.07

1636. MEASUREMENT OF THE RISE-TIME OF PULSES IN $BF_3$ PROPORTIONAL COUNTERS. W.Dąbek and A.Kazimierski.
Nukleonika, Vol. 3, No. 3, 299-312 (1958). In Polish.

A method is described of measuring the rise-time of pulses in a proportional counter. The method is based on the measurement of changes in pulse amplitude produced by the application of differentiating and integrating circuits. The amplifier used in the measurements had a known constant integration time and an additional differentiating circuit of variable time constant. The pulse rise-times measured in three types of proportional counters ranged from 0.3 to 0.9 $\mu$sec. A.

539.1.07

1637. A PORTABLE SCINTILLATION ALPHA SURVEY INSTRUMENT. W.G.Spear.
I.R.E. Trans Nuclear Sci., Vol. NS-4, No. 2, 63-5 (Dec., 1957).

The counter utilizes a ZnS fluor, a multiplier phototube, and a two-stage vacuum tube amplifier. A neon-bulb oscillator high-voltage supply is used to supply 900 V to the multiplier phototube, and headphones are used to obtain an aural indication of counting. The average geometry or counting efficiency over the 7.43 in.$^2$ probe area is approximately 13%, with variations from a maximum counting efficiency at the probe centre of 18 to 22% down to approximately 7 to 8% at the probe edges. The background counting rate is less than 1 count/min, and the battery life is approximately 150 hr of continuous operation.

539.1.07 : 621.387.464

1638. SCINTILLATION COUNTING - 1958.
Nucleonics, Vol. 16, No. 6, 54-9 (June, 1958).

A review of developments reported at the sixth Scintillation Counter Symposium, Washington, January 1958 (see Abstr. 5163/1958). Organic phosphors have been found to have a slow component of decay whose intensity depends on the nature of the ionizing particle. In this way neutrons which cause the emission of a larger proportion of the slow component may be differentiated from $\gamma$-rays. Plastic phosphors containing up to 7% Pb and giving 50% of the pulse-height of the metal-free plastic have been made using salts such as lead octoate methacrylate. The "Vernier Chronotron" measures the time interval between two pulses by causing them to circulate in two delay line loops of slightly different delay times. The number of transits before the pulses arrive in coincidence at a detector gives the time interval in terms of the difference in transit times (1m$\mu$s). New photomultipliers have reduced transit-time spreads by using spherical photocathodes and special optical systems.

R.D.Smith

539.1.07 : 539.163.1

1639. THE USE OF A SAMARIUM LOADED LIQUID SCINTILLATOR FOR THE DETERMINATION OF THE HALF-LIFE OF $Sm^{147}$. G.B.Beard and W.H.Kelly.
Nuclear Phys., Vol. 8, No. 2, 207-9 (Sept. [2], 1958).

An investigation of the use of metal-loaded organic-liquid scintillators for the study of long-lived alpha-emitters was carried out. The method was checked using a samarium-loaded scintillator. A specific activity corresponding to a half-life of $(1.28 \pm 0.04) \times 10^{11}$ years for the alpha decay of $Sm^{147}$ was found. This is in agreement with the published half-life measured using a different technique.

539.1.07

1640. NEW DEVELOPMENTS IN SCINTILLATION COUNTERS. W.Hanle and H.Schneider.
Z. angew. Phys., Vol. 10, No. 5, 228-48 (May, 1958). In German.

An up-to-date review of scintillation counters is given, including comparison of different types of photomultiplier, associated circuits and phosphors. Inorganic crystals, organic crystals and liquids and plastic phosphors are included. A large section is devoted to recent uses of the counter in nuclear studies.

G.F.J.Garlick

539.1.07 : 535.376

RESPONSE OF A LIQUID SCINTILLATOR TO FAST NEUTRONS AND $\gamma$ RADIATION. See Abstr. 1319

539.1.07

1641. 30-INCH PROPANE BUBBLE CHAMBER. W.M.Powell, W.B.Fowler and L.O.Oswald.
Rev. sci. Instrum., Vol. 29, No. 10, 874-9 (Oct., 1958).

A propane bubble chamber with a sensitive volume of $30\frac{1}{2} \times 21\frac{1}{2} \times 6\frac{1}{2}$ in. operating in a magnetic field of 14 000 G is described. Operating parameters and some engineering details are given. The part of the chamber containing the propane is hydrostatically supported in oil through which the chamber is photographed. This permits the use of small glass windows with a large safety factor.

539.1.07 : 539.17

1642. A SIMPLE METHOD FOR CHARGE DETERMINATION OF HEAVY FRAGMENTS FROM NUCLEAR DISINTEGRATIONS. O.Skjeggestad.
Arch. Math. Naturvid., Vol. 54, No. 1, 8 pp. (1956).

A method for charge determination of heavy fragments from cosmic-ray stars in photographic emulsions is described. A drawing of the fragment track is made by means of a projection microscope, and the total track area is measured with a planimeter. The track areas are clearly separated into groups corresponding to different values of the charge. The method is compared with that of measuring thin-down length.

539.1.07 : 535.822.1

1643. PRECISION MICROSCOPE FOR [ANALYSIS OF] LARGE NUCLEAR PLATES. I.Kalberg, D.M.Haskin, M.Schein and G.T.Zorn.
Rev. sci. Instrum., Vol. 29, No. 8, 697-8 (Aug., 1958).

A microscope with coordinate motions of 21 × 15 cm is described, with particular attention given to constructional details. The design includes a magnetic clutch for fixing plate position, a rotating super-stage and dial indicators to observe both horizontal and vertical movement. A stage noise $\leq 0.029$ $\mu$ for cell lengths up to 1 mm was obtained.

539.1.07 : 539.12

1644. ON THE LIMITS OF RESOLVING POWER OF PARTICLE SPECTROMETERS. L.Marton.
Bull. Acad. Roy. Belgique Cl. Sci, Vol. 44, No. 3, 159-62 (1958). In French.

A comparison of the theoretical limits of resolving power based on the uncertainty principle with those achieved in practice in some $\beta$-spectrometers. M.A.Grace

539.1.07 : 533.59

EASILY MOUNTED ALUMINIUM OXIDE FOILS FOR WINDOWS AND BACKINGS. See Abstr. 116

539.1.07 : 537.591

OPTICS OF COSMIC-RAY TELESCOPES. See Abstr. 1565

# ELEMENTARY PARTICLES

539.12

1645. BREMSSTRAHLUNG AND PAIR PRODUCTION OF PARTICLES OF SPIN $\frac{3}{2}$. A.A.Komar.
Nuclear Phys., Vol. 9, No. 1, 6-21 (Nov. [3], 1958).

Bremsstrahlung and pair production for spin $\frac{3}{2}$ particles are computed in the lowest perturbation theory approximation. The ultrarelativistic case is considered in detail. The importance of small impact parameters is demonstrated. For a pure Coulomb nuclear field the cross-sections are proportional to $E^6$, where E is the incident particle or photon energy. The effect of deviation of the nuclear electric field from that of a point Coulomb source is discussed.

539.12

1646. BOUND STATES AND SCATTERING OF BARYONS IN CONTACT INTERACTION. I.V.Polubarinov.
Nuclear Phys., Vol. 8, No. 4, 444-60 (Oct. [2], 1958).

The possibility of treating $\pi$ and K-mesons as bound states in the four-baryon interaction theory is considered. The cross-section for baryon—baryon scattering is derived within the framework of this theory in the chain approximation. The validity of the first approximation of perturbation theory for the cross-section is discussed.

539.12 : 530.145

1647. TIME REVERSAL AND POLARIZED NUCLEAR REACTIONS. G.R.Satchler.
Nuclear Phys., Vol. 8, No. 1, 65-8 (Sept. [1], 1958).

Providing the interactions responsible are invariant under time reversal, it is shown there is a simple general relation between the spin polarization moments produced in a collision process, and the angular distribution induced by these moments in the time inverse collision.

539.12 : 539.14

HIGH-ENERGY SCATTERING. See Abstr. 580

539.12

1648. ON THE LONGITUDINAL AND SCALAR PHOTONS. S.Sunakawa, T.Imamura and R.Utiyama.
Annu. Rep. Sci. Works Fac. Sci. Osaka Univ., Vol. 6, 1-11 (1958).

This is (a) an account of a limiting procedure for normalizing the longitudinal and scalar photon components of the state vectors in quantum electrodynamics, and (b) a critique of Gupta's (Abstr. 6997/1950) indefinite metric formalism, on the grounds that it is not covariant. J.C.Taylor

539.12

1649. ON ELECTROMAGNETIC CORRECTIONS FROM HIGH ENERGY VIRTUAL PHOTONS. R.Gatto and M.Ruderman.
Nuovo Cimento, Vol. 9, No. 3, 556-9 (Aug. 1, 1958).

Examines the suggestion that a large electromagnetic correction to the mass of the electron may be responsible for the apparent absence of the decay process $\pi \rightarrow e + \nu$. It is pointed out that it is physically unreasonable to include the effects of very high energy virtual photons in this way. Other consequences of a purely electromagnetic mass for the electron are examined. J.M.Cassels

539.12 : 539.2

CHARACTERISTIC ENERGY LOSS OF ELECTRONS IN GRAPHITE. See Abstr. 790

539.12

1650. THE MØLLER SCATTERING OF ARBITRARILY POLARIZED ELECTRONS. R.Rączka and A.Raczka.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 7, 463-8 (1958).

The differential cross-section for this process is calculated to lowest order; a different result obtained by Ford and Mullin (Abstr. 7235/1958) is criticized. Possible applications to the measurement of transverse electron polarization are discussed.

R.J.N.Phillips

539.12

1651. SCATTERING OF POLARIZED ELECTRONS BY A COULOMB FIELD. M.Bernardini, P.Brovetto and S.Ferroni.
Nuclear Phys., Vol. 8, No. 3, 294-302 (Oct. [1], 1958).

In this work some equations, concerning the cross-section and polarization of a fermion beam scattered by a central field, are obtained by means of the density-matrix formalism. These equations are applied to the case of electrons scattered in a Coulomb field. The precession of the polarization is given as a function of velocity for some values of the parameters. The double scattering experiment in orthogonal planes is discussed as a technique for evaluating the longitudinal component of the electron polarization.

539.12

1652. BREMSSTRAHLUNG FROM MULTIPLE SCATTERING. J.S.Bell.
Nuclear Phys., Vol. 8, No. 5, 613-20 (Nov. [1], 1958).

It has been predicted, by largely classical arguments, that destructive interference of the radiation from many collisions greatly reduces the rate of energy loss by very high energy electrons undergoing multiple scattering. It is observed that this is incompatible with a standard formula in classical theory, and the discrepancy is traced to an inadequate account of the high frequency part of the radiation spectrum. It is concluded that any real effect of this kind is of essentially quantal origin.

539.12

1653. ANNIHILATION OF POLARIZED POSITRONS IN FERROMAGNETIC MATERIALS. I.Lovas.
Acta phys. Hungar., Vol. 8, No. 4, 441-5 (1958).

It is suggested that the problem of determining which electrons in a metal are responsible for positron annihilation could be cleared up by studying the angular correlations of the gamma-rays from two-photon annihilation of polarized positrons in a magnetized ferromagnetic material. S.J.Goldsack

539.12

1654. THEORETICAL STUDY OF PAIR CREATION IN THE FIELD OF AN ELECTRON. J.Reyntjens.
Ann. Soc. Sci. Bruxelles I, Vol. 71, No. 3, 189-203 (1957).
In French.

A general formula is deduced for the cross-section for pair formation in the field of an electron, using the perturbation method of Feynman and Dyson. The calculation takes account of the recoil of the electron in whose field the pair is formed, and of exchange phenomena. Formulae are given for the total cross-section in four cases: (1) all three particles and the incident photon have high energy; (2) the initial electron has low recoil energy, but both particles of the pair and the initial photon have high energy; (3) the positron has low energy, but both electrons and the initial photon have high energy; (4) near threshold. Comparisons are made with previous calculations and with the scanty experimental information.

A.Ashmore

539.12

1655. MEASUREMENTS OF ABSOLUTE PAIR PRODUCTION CROSS SECTIONS AT LOW ENERGIES. S.Standil and V.Shkolnik.
Canad. J. Phys., Vol. 36, No. 9, 1154-60 (Sept., 1958).

Using an improved analysis in conjunction with a relative method for the measurement of absolute pair-production cross-sections, the pair-production cross-sections per atom of lead were measured for the gamma-rays emitted by $Co^{60}$ and $Sb^{124}$. The Z-dependence of this cross-section was measured for the $Co^{60}$ radiation using targets of Al, Fe, Cu, Mo, Ag, Sn, and Pb. The results obtained are generally in agreement with other experimental determinations and are, along with those of other investigators, presented graphically.

539.12 : 530.145

1656. NUCLEON SPECTRUM IN STRONG-COUPLING THEORY. L.Landovitz and B.Margolis.
Phys. Rev. Letters, Vol. 1, No. 6, 206-7 (Sept. 15, 1958).

A rotational band of excited nucleon levels is derived from strong-coupling symmetric pseudoscalar meson theory. Numerical values are estimated by assuming Yukawa shape for the nucleon source factor, and associating the lowest level ($J = \frac{3}{2}, T = \frac{3}{2}$) with the well known pion—nucleon resonance at 300 MeV.

R.J.N.Phillips

539.12 : 539.14

ELECTROMAGNETIC STRUCTURE OF THE PROTON AND NEUTRON. See Abstr. 573

539.12

1657. A NOTE ON CHARGE INDEPENDENCE AND NUCLEON—ANTINUCLEON INTERACTIONS. S.K.Srinivasan.
Proc. Indian Acad. Sci. A, Vol. 47, No. 6, 365-8 (June, 1958).

Purports to derive a relation between nucleon—antinucleon scattering and annihilation against two pions from isobaric spin conservation. The work ignores spin, and tacitly assumes the isobaric spin amplitudes for this annihilation mode are the same as for scattering. R.J.N.Phillips

539.12

1658. SOME POSSIBLE EXPERIMENTS FOR THE INVESTIGATION OF INELASTIC SCATTERING OF NUCLEONS. L.M.Soroko.
Nuclear Phys., Vol. 7, No. 6, 579-90 (Aug., 1958).

Some possible experiments are considered which can be used to study inelastic collisions of nucleons of the type $N+N \rightarrow \pi+N+N'$. Processes of this type are most frequent in the $\approx$ 650 MeV energy region. Some non-trivial experiments on the $\pi$-meson—nucleon angular correlation are indicated which are based on the existence of azimuthal asymmetry in the emission of these two particles. Similar effects for a polarized nucleon beam are considered. The calculations are performed in terms of ten inelastic transition amplitudes, it being assumed that these transitions yield the main contribution to the total cross-section of the $N+N \rightarrow \pi+N+N'$ process at 650 MeV.

539.12 : 539.17

1659. ON THE INELASTIC SCATTERING OF NUCLEONS BY NUCLEI AT HIGH ENERGIES. H.S.Köhler.
Nuclear Phys., Vol. 9, No. 1, 49-64 (Nov. [3], 1958).

The inelastic scattering of high-energy nucleons by nuclei was treated taking account of the nuclear distortion of the scattered wave in the high-energy approximation. Using the collective model and including a Thomas-type spin—orbit interaction, treated as a perturbation, the explicit expression for the polarization previously obtained for elastic scattering is generalized to inelastic scattering as

well. The many-body problem of inelastic scattering is considered following the methods of Watson et al. (see Abstr. 1060/1954). This treatment is limited to transitions for which the two-nucleon scattering matrix is reduced as it is in elastic scattering on spin-zero nuclei. Then an explicit expression for the polarization is again derived similar to that for the elastic scattering but reflecting the angular dependence of nucleon–nucleon scattering.

539.12

1660. EFFECTS OF ATOMIC ELECTRONS ON p–p AND n–p SCATTERING. G.Breit.
Phys. Rev. Letters, Vol. 1, No. 6, 200-3 (Sept. 15, 1958).

This theoretical paper looks into the possibility that the screening effect, hitherto assumed to be small, may prove to be non-negligible at low energies (< 10 MeV). Coulomb excitation of the molecular electrons and acceleration of the target atom are considered. These effects interfere with the employment of low energy data for p-wave anomaly detection and increase the relative importance of higher energy work. R.H.W.Johnston

539.12

1661. PROTON–PROTON SCATTERING AT ENERGIES FROM 46 TO 147 MeV.
J.N.Palmieri, A.M.Cormack, N.F.Ramsey and R.Wilson.
Ann. Phys. (New York), Vol. 5, No. 4, 299-341 (Dec., 1958).

The angular distribution of the differential cross-section and polarization in proton–proton scattering were measured at 147, 118, 95, and 66 MeV; at the highest energy the angular range was $4^\circ$ to $112^\circ$ (centre of mass), while at the other energies the region considered fell between about $20^\circ$ and $80^\circ$. In each case the differential cross-section is a few percent higher at $40^\circ$ than at $90^\circ$, in disagreement with the recent results of Taylor at Harwell. The angular distribution of $Pd\sigma/d\Omega$ indicates the necessity for F-waves in describing the interaction at 147 MeV, although these are not required at the lower energies. Measurements of the polarization at $45^\circ$, taken at 10 MeV intervals between 46 and 147 MeV, yield results about 20% higher than predicted by Gammel and Thaler (Abstr. 7971/1957).

539.12

1662. PROTON–PROTON SCATTERING WITH UNPOLARIZED BEAM AND TARGET. K.Skarsvåg.
Nuclear Phys., Vol. 8, No. 1, 55-60 (Sept. [1], 1958.

The general form of the scattering matrix in the singlet-triplet representation is found, and the formulae for the differential cross-section, the polarization and the correlation coefficients are derived.

539.12 : 539.17

1663. THE ELASTIC SCATTERING OF PROTONS BY TRITONS AND $^3$He. B.H.Bransden and H.H.Robertson.
Proc. Phys. Soc., Vol. 72, Pt 5, 770-80 (Nov., 1958).

This paper describes the extension of earlier work on the elastic scattering of neutrons by tritons and $He^3$ to proton scattering over the energy range 1 to 14 MeV. Cross-sections and phase-shifts are calculated assuming central two-body interactions, of various exchange types and of Gaussian radial form. Comparison with experiment favours the Serber rather than the symmetrical type of exchange interaction. Detailed agreement between the calculated and experimental cross-sections is, however, lacking at the lowest energies.

539.12 : 530.145

EXPERIMENTAL TEST OF TIME-REVERSAL INVARIANCE IN STRONG INTERACTIONS. See Abstr. 1059

539.12 : 539.17

POLARIZATION OF PROTONS FROM $B^{10}(d,p)B^{11}$, $C^{12}(d,p)C^{13}$. See Abstr. 658

539.12

1664. INELASTIC SCATTERING OF PHOTO-NEUTRONS IN THE ENERGY RANGE FROM 0.3 TO 1 MeV. H.Pose and N.Glaskow.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 4-19 (1957). In German.

The inelastic scattering cross-sections of 13 elements were measured for 0.26, 0.71 and 0.95 MeV photo-neutrons. The energies of certain excitation levels of a number of these elements were found. The results were related to those already measured in other energy ranges. The photo-neutron sources, such as $Na^{24}$ + Be, were placed inside spheres of the scattering materials. The spectra of the scattered neutrons were investigated by measuring the energies of the recoil nuclei in an ionization chamber. D.H.Lord

539.12 : 538.114

SCATTERING OF SLOW NEUTRONS IN FERROMAGNETICS. See Abstr. 1578

539.12

1665. FORM FACTORS IN $\beta$ DECAY AND $\mu$ CAPTURE.
M.L.Goldberger and S.B.Treiman.
Phys. Rev., Vol. 111, No. 1, 354-61 (July 1, 1958).

It is supposed that $\beta$ decay and $\mu$ capture are described by a universal vector and axial vector Lagrangian and the authors consider, via dispersion relation techniques, the properties of the corresponding S-matrix elements. Owing to the strong interactions of the nucleons, the structure of the S matrix is expected to be more complicated than that of the Lagrangian. In the former, vector and axial vector terms appear, but with coefficients which in general depend on the invariant nucleon momentum transfer; they can be thought of as Fermi interaction form factors. Moreover, two additional kinds of terms can appear in the S-matrix elements: one which simulates a direct pseudoscalar coupling and one which simulates a direct coupling involving derivatives of the nucleon wave-functions. The latter is probably too small to have any experimental significance. The former, though negligible in $\beta$ decay, may be appreciable in $\mu$ capture. The effective pseudoscalar coupling coefficient there is estimated to be about eight times as large as the axial vector coefficient. More generally, the structure of the various form factors is investigated, and, in further refinement, a recent quantitative discussion of $\pi \rightarrow \mu + \nu$ decay is reconsidered.

539.12 : 539.165

BETA-DECAYS AND TIME REVERSAL. See Abstr. 621

539.12

1666. SEARCH FOR MASS-550 PARTICLES.
J.W.Keuffel, R.L.Call, W.H.Sandmann and M.O.Larson.
Phys. Rev. Letters, Vol. 1, No. 6, 203-5 (Sept. 15, 1958).

An electronic apparatus was exposed to cosmic rays at 4700 ft. Particle mass was measured by ionization loss in a thin scintillator together with total energy released in the large liquid scintillator in which the particle was stopped. Each stopping particle was examined for decay products for times ranging from $10^{-7}$ to $10^{-1}$ sec. A maximum abundance of 0.05% relative to muons was found, unless the charged decay product is an electron and the lifetime longer than 10 msec. R.H.W.Johnston

539.12

1667. DETERMINANTAL APPROACH TO MESON–NUCLEON SCATTERING. M.Baker.
Ann. Phys. (New York), Vol. 4, No. 3, 271-305 (July, 1958).

A treatment of scattering is presented where the construction of the scattering phase shifts is regarded as an energy value problem. Using the relation between the phase shift $\delta(E)$ and the energy shift $\Delta E$, the phases can be obtained directly from the infinite determinant

$$D(E) = \det\left(\frac{E - H}{E - H_0}\right) = \prod_k \left(\frac{E - E_k}{E - E_{0k}}\right) = \prod_k \left(1 - \frac{\Delta E_k}{E - E_{0k}}\right),$$

where $E_k$ are the energy eigenvalues of the interacting system and $E_{0k}$ are the corresponding eigenvalues for the noninteracting system. For the problem of potential scattering this procedure is directly applicable and leads to results equivalent to the Fredholm solution of the scattering integral equation. However, for the case of interest, the interacting meson–nucleon system D(E) does not exist, and in order to apply this method, D(E) must be factorized into convergent subdeterminants $D_i(E)$, each of which refer to a particular class of states. From $D_1(E)$, the subdeterminant referring to a one-meson type state, the scattering phase shifts can be calculated. A procedure for constructing $D_1(E)$ for the meson–nucleon system is developed by using the formal structure of D(E). This method is then applied to calculate meson–nucleon scattering in the static model. $D_1(E)$ is expanded in a power series. The first two terms of the expansion yield a solution for the phase shift similar to results given by the Chew–Low one-meson approximation. Finally the result of a preliminary calculation with the fully relativistic interaction is discussed.

539.12

1668. ON SCHWINGER'S THEORY OF THE MUON. W.S.Cowland
Nuclear Phys., Vol. 8, No. 4, 397-401 (Oct. [2], 1958).

The muon self-mass and the contribution to the anomalous muon magnetic moment, arising from an interaction with a heavy Bose particle ($\sigma$) postulated by Schwinger, are calculated in lowest order perturbation theory. The parameters involved are then investigated to see whether a large muon self-mass is compatible with the observed magnetic moment of the muon. It is found that,

with some reservations, they are compatible when the σ-particle has scalar space-time character.

539.12

1669. ENERGY DEPENDENCE OF THE SPATIAL ASYMMETRY IN POLARIZED MUON DECAY.
J.M.Cassels, T.W.O'Keeffe, M.Rigby and J.R.Wormald.
Proc. Phys. Soc., Vol. 72, Pt 5, 781-5 (Nov., 1958).

The spatial asymmetry of the positrons from polarized muon decay was measured, with and without discrimination in favour of high energies. The high-energy positrons were found to be more asymmetric than the average, and the effect is quantitatively consistent with the two-component neutrino theory.

539.12

1670. A POSSIBLE EXPERIMENT FOR DETERMINATION OF SPIRALITY OF μ-MESONS. A.Z.Dolginov.
Nuclear Phys., Vol. 7, No. 6, 569-72 (Aug., 1958).

For the determination of the direction of the μ-meson spin with respect to its momentum it is suggested that circular polarization of X-ray quanta emitted by a mesic atom be investigated. This should simultaneously yield information on the degree of depolarization of μ-mesons after a certain level is reached in the mesic atom.

539.12 : 539.17

1671. CAPTURE RATES FOR NEGATIVE MUONS IN VARIOUS ELEMENTS. A.Astbury, M.A.R.Kemp, N.H.Lipman, H.Muirhead, R.G.P.Voss, C.Zangger and A.Kirk.
Proc. Phys. Soc., Vol. 72, Pt 4, 494-8 (Oct., 1958).

An experiment is described in which the capture rates of negative muons were measured for selected elements. A comparison between the experimental results and the theoretical predictions of Tolkoek and Luyten (Abstr. 2485/1958) suggests that tensor and/or axial vector couplings are favoured in the interaction.

539.12 : 539.17

CAPTURE OF NEGATIVE MUONS BY LIGHT NUCLEI. See Abstr. 694

539.12

1672. ON THE SYMMETRY LAW AND THE PION DECAY.
H.Umezawa and H.Miyazawa.
Nuovo Cimento, Vol. 9, No. 4, 586-9 (Aug. 16, 1958).

Assuming the global symmetry of strong pion interactions, a simple combination of the V- and A-types, β-interaction is introduced to explain the problem of the β- and radiative β-decays of the pion. This combination is in good accordance with the rule that the weak interactions are invariant under the transformation, under which the nucleon and the Ξ are interchanged and $\gamma_5$ appearing in the baryon changes its sign.

539.12

1673. IMPULSE APPROXIMATION AND DISPERSION RELATIONS FOR PION—DEUTERON SCATTERING. F.Kaschluhn.
Nuclear Phys., Vol. 8, No. 3, 303-9 (Oct. [1], 1958).

The recently derived dispersion relation for elastic forward scattering of pions by unpolarized deuterons is compared with the experimental data in the Chew impulse approximation. It is shown that the dispersion relation is consistent with these data. However, for a more detailed test of the theory it is necessary to consider other π—D processes for which the contribution from the non-observable part in the dispersion relations is not a small quantity. It is indicated that for this purpose consideration of the elastic forward scattering amplitude for spin-flip is sufficient.

539.12 : 539.17

1674. THE PHOTOPRODUCTION OF $\pi^0$ MESONS AT HELIUM.
P.Palit and E.H.Bellamy.
Proc. Phys. Soc., Vol. 72, Pt 5, 880-6 (Nov., 1958).

The elastic photoproduction of neutral mesons from helium was studied at centre-of-mass angles of 70°, 90°, 115° and 135° for the meson in the photon energy range 220-320 MeV. The reaction was identified by detecting the recoiling $He^4$ particles in a pair of gridded ionization chambers which discriminated against other particles by dE/dx and E measurements. The measured cross-sections are compared with the predictions of an impulse approximation calculation with which they are in qualitative agreement. They are smaller by an order of magnitude than some of the previous measurements of this reaction.

539.12

1675. WILSON—PEIERLS AMBIGUITY IN HIGH-ENERGY PHOTOPRODUCTION. J.J.Sakurai.
Phys. Rev. Letters, Vol. 1, No. 7, 258-60 (Oct. 1, 1958).

Alternative explanations of the second peak in the single pion photoproduction spectrum involves excited isobaric states with $J = \frac{1}{2}$, $J = \frac{3}{2}$ and even (Wilson) or odd (Peierls) parity. Theoretical reasons are given suggesting that this may be resolved by measuring the polarization of the recoil proton in the reaction

$$\gamma + p \rightarrow p + \pi^0$$

and that the experiment is feasible making use of the 100% analysing power of proton—carbon scattering for 220 MeV protons at optimum angles. R.H.W.Johnston

539.12

1676. PHOTOPION CROSS SECTIONS AND A SECOND RESONANCE. R.F.Peierls.
Phys. Rev. Letters, Vol. 1, No. 5, 174-5 (Sept. 1, 1958).

It is suggested that the $\pi^+$-production can be better described if the T = 1/2, J = 3/2 resonant state postulated earlier (Abstr. 7245/1958) is assigned odd parity. P.K.Kabir

539.12 : 539.17

PHOTOPRODUCTION OF $\pi^-$-MESONS FROM BORON. See Abstr. 676

539.12 : 539.17

PHOTOPRODUCTION OF NEGATIVE PIONS FROM DEUTERIUM. See Abstr. 696

539.12

1677. DECAY MODES AND LIFETIME OF NEGATIVE HEAVY MESONS. S.Nilsson and Å.Frisk.
Ark. Fys., Vol. 14, Paper 19, 293-302 (1958).

Twenty-one events representing possible decays of a $K^-$-meson in emulsion were measured in order to get the relative abundances of different decay modes, an estimate of the contamination from nuclear reactions and a determination of the mean lifetime. Events consistent with $\tau^-$, $K^-_{\mu 2}$, $K^-_{\mu 3}$, $K^-_{\pi 2}$, $K'^-_{\pi 3}$ and $K^-_{\beta 3}$ were found. The ratio $\tau^-/K^-_L + \tau^- = 0.15$ and $K^-_{\pi 2}/K^-_{\mu 2} = 0.43$. The percentage of nuclear reactions among the events with one charged secondary was ~20%. The mean lifetime $\tau_{K^-} = (1.50^{+0.45}_{-0.30}) \times 10^{-8}$ sec. Three $\tau^-$ are reported and from one $\tau^-$ the mass of the negative τ-meson was $m_{\tau^-} = 494.4 \pm 1.2$ MeV.

539.12

1678. ON THE DECAY OF POSITIVE K-MESONS. P.Surányi.
Acta phys. Hungar., Vol. 8, No. 4, 447-9 (1958).

The author suggests that the $\tau^+$-meson and the $\theta^+$-meson are different, a $\tau^+$ decaying by virtual emission of a $\theta^+$. The $K_{\mu 3}$ and $K_{\mu 2}$ decays are interpreted as alternative decays of $\tau^+$ and $\theta^+$ respectively. The experimental results on the frequencies of the different types of decay give some support for this model. S.J.Goldsack

539.12 : 530.145

A PARITY-CONSERVING INTERACTION APPLIED TO K—PION DECAY. See Abstr. 1054

539.12

1679. LONG-LIVED NEUTRAL K MESONS.
M.Bardon, K.Lande, L.M.Lederman and W.Chinowsky.
Ann. Phys. (New York), Vol. 5, No. 2, 156-81 (1958).

The results of a complete analysis of photographs obtained by the Columbia 36 in. magnet cloud chamber in neutral beams of the Brookhaven Cosmotron are presented. A "short-distance" exposure yielded 152 events giving unambiguous proof of the existence of long-lived neutral V-particles, most naturally interpreted as examples of $K_2^0$ disintegrations. In a subsequent "long-distance" run, 34 events were found, giving a lifetime for $K_2^0$ of $8.1^{+3.2}_{-2.4} \times 10^{-8}$ sec. Decay modes identified were: $\pi^\pm e^\mp$ plus a neutral; $\pi^\pm \mu^\mp$ plus a neutral and $\pi^+\pi^-$ plus a neutral. These are most economically interpreted as the neutral counterparts of $K^+$ decay, i.e. $\pi^\pm e^\mp \nu$, $\pi^\pm \mu^\mp \nu$, and $\pi^+\pi^-\pi^0$. In this case, the first two constitute the bulk of the events, the $\tau^0$ mode being <~ 15% of the total sample. No evidence is found for 2-body disintegrations. Recent literature on the subject of $K_2^0$ is briefly reviewed.

539.12

1680. ON THE DISPERSION RELATIONS AND THE DEDUCTION OF EQUATIONS FOR K-MESON SCATTERING. A.M.Brodskiĭ.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1531-8 (1958). In Russian.

Scattering of K-mesons on nucleons is investigated taking into account Σ-particle formation. Besides the usual principles of the standard theory, use is made of the causality condition and unitarity condition on the S-matrix. These conditions along with the additional assumption of invariance of the interaction with respect to rotations in four-dimensional isotopic space yield Low-type equations which are valid at not very high energies and are similar to the Low equa-

tions for $\pi$-meson scattering. The form of the interaction enters the equation by means of an inhomogeneous term. The equations obtained are also a generalization of the dispersion relations for scattering by arbitrary angles. Similar equations for scattering of $\pi$-mesons were obtained earlier (Abstr. 276/1958) in which, however, a special spectral representation of the scattering matrix was employed (Abstr. 57/1956; 3963/1957). This spectral representation is not used in the present paper.

539.12

1681. DECAY OF A NEGATIVE $\tau'$ MESON.
S.C.Freden, F.C.Gilbert and R.S.White.
Phys. Rev. Letters, Vol. 1, No. 6, 217-18 (Sept. 15, 1958).

This event was observed in emulsion in the course of a study of $K^-$ decays and interactions in flight. The secondary $\pi^-$ was accompanied by an e-pair. Decay kinematics and ionization measurements rule out the $K\pi_3$ mode. The probabilities of various decay-like capture processes are estimated and found to be relatively small, due to the presence of the e-pair.

R.H.W.Johnston

539.12

1682. ANTI-LAMBDA HYPERON.
D.J.Prowse and M.Baldo-Ceolin.
Phys. Rev. Letters, Vol. 1, No. 5, 179-80 (Sept. 1, 1958).

This event was found in emulsion exposed to the 4.6 BeV negative pion beam at the Berkeley Bevatron. Positive pions were found by area scanning and traced back to their point of origin. One such was found to emerge from a V-event, the other branch of which interacted after 3 cm giving a large star with shower particles. Direction of motion from V-event to star was established by careful ionization measurements. Using the ionization estimate for the antiproton energy at the $\Lambda^0$ decay point a Q-value of $35^{+2.6}_{-0.9}$ was obtained.

R.H.W.Johnston

539.12

1683. NUCLEON POLARISATION IN $\Lambda$ DECAY. J.Szymański.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 9, 893-5 (1957).

With non-conservation of parity, the nucleons from $\Lambda$ decay may be polarized. The most general S-matrix element satisfying invariance conditions is written down, and the resulting polarization is obtained as a function of the constants appearing there. For an equal parity conserving and parity non-conserving interaction, the polarization is $v/c$, where v is the nucleon velocity.

S.J.Goldsack

539.12

1684. DETERMINATION OF THE RELATIVE $\Sigma-\Lambda$ PARITY.
G.Feldman and T.Fulton.
Nuclear Phys., Vol. 8, No. 1, 106-12 (Sept. [1], 1958).

An investigation has been undertaken to determine whether there are definitive experiments which can determine, at least in principle, the relative $\Sigma-\Lambda$ parity. Two such methods are discussed. They are both based upon the parity-conserving electromagnetic decays of the $\Sigma^0$. The first involves the process $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. It is necessary to measure the decay asymmetries of the $\Lambda^0$ together with the direction of the photon polarization. The second method (also calculated recently by Feinberg) involves an accurate measurement of the branching ratio for the reactions $\Sigma^0 \rightarrow \Lambda^0 + e^+ + e^-$ and $\Sigma^0 \rightarrow \Lambda^0 + \gamma$. The appendix is concerned with some properties of a general vertex part.

539.12 : 539.14

$\Lambda$-NUCLEON POTENTIAL FROM HYPERFRAGMENT DATA.
See Abstr. 594

539.12

1685. APPLICATION OF THE SERBER POTENTIAL TO LOW ENERGY HYPERON–NUCLEON SCATTERING. D.B.Lichtenberg.
Nuclear Phys., Vol. 8, No. 1, 13-18 (Sept. [1], 1958).

Theoretical expressions for the hyperon–nucleon scattering cross-sections at low energy are derived which give these cross-sections as simple linear combinations of the nucleon–nucleon cross-sections. The assumptions necessary for this derivation are: (a) there exists a universal coupling between pions and baryons, and (b) the nucleon–nucleon interaction can be described by a Serber potential. In addition, the approximations must be made of neglecting effects of K-mesons and baryon mass differences. The restriction to low energy is necessary because the assumption is needed that the scattering be appreciable only when the hyperon and nucleon are in a state of zero orbital angular momentum.

539.

1686. $\Lambda^0$-AND $\theta^0$-PARTICLES PRODUCED IN IRON.
G.Alexander, C.Ballario, R.Bizzarri, B.Brunelli, E.Di Capua, A.Michelini, G.C.Moneti and A.Zichichi.
Nuovo Cimento, Vol. 9, No. 4, 624-46 (Aug. 16, 1958).

The results of an experiment on some properties of $\Lambda^0$ and $\theta^0$ particles produced in the plates of a cloud chamber are discussed. 115 $V^0$-events are analysed by means of angle measurements and ionization estimates. The frequency of production of $\Lambda^0$, $\theta^0$ pairs is found to be small. For neither type of particle is any evidence found for anisotropy in the decays. The $V^0$ production cross-secti appears larger for a pion primary than for a nucleon, and increase with the energy released in the shower.

539.1

1687. SEARCH FOR PARITY NONCONSERVATION IN THE ASSOCIATED PRODUCTION PROCESS.
F.S.Crawford,Jr, M.Cresti, M.L.Good, F.T.Solmitz and M.L.Stevenson.
Phys. Rev. Letters, Vol. 1, No. 6, 209-12 (Sept. 15, 1958).

If parity is not conserved in the associated production process $\pi^- + p \rightarrow \Lambda + K^0$, the subsequent $\Lambda$-decay process must have an asymmetry in the production plane. An attempt to detect the latter gets results consistent with zero asymmetry. If there is a parity-nonconserving contribution to the production, its fractional intensit is only $0.07 \pm 0.08$.

R.J.N.Phillip

539.1

1688. HIGH ENERGY SCATTERING OF DEUTERONS BY COMPLEX NUCLEI. S.Watanabe.
Nuclear Phys., Vol. 8, No. 4, 484-92 (Oct. [2], 1958).

An effective deuteron–nucleus potential consisting of an optica well plus a spin–orbit interaction was derived, starting from a Saxon potential plus a spin–orbit term for the interaction between each nucleon in the deuteron and the nucleus. The WKB method was used to calculate the angular distribution and the polarization c 94 MeV deuterons by carbon. The result of this calculation using well parameters which fit the scattering data of 40 MeV protons by carbon, is in good agreement with the measured values of the diffe ential cross-section. The predicted polarization shows a maximum of about 30%, but its sign is constant and does not oscillate as the experimental one does.

539.12 : 530.145

DEUTERON SCATTERING BY SPIN 0 NUCLEI. See Abstr. 1074

539.12 : 539.1

1689. THE (d,t) REACTIONS AND THE INTERNAL STRUCTURE OF THE TRITON. M.El Nadi and L.Abou Hadid.
Nuclear Phys., Vol. 8, No. 1, 51-4 (Sept. [1], 1958).

From the experimental values of the differential cross-section for $Li^7(d,t)Li^6$ and $Li^7(p,d)Li^6$, $F^{19}(d,t)F^{18}$ and $F^{19}(p,d)F^{18}$, the probab ility for the existence of the triton in the configuration of a deuteron ground state plus a second neutron was calculated and found to be very small.

539.1

1690. CLASSIFICATION OF TRITON WAVE FUNCTIONS.
G.Derrick and J.M.Blatt.
Nuclear Phys., Vol. 8, No. 3, 310-24 (Oct. [1], 1958).

A classification of all angular momentum-isobaric spin functio which can be present in the ground-state wave-function of $H^3$ is carried out by methods of group theory. This classification, based on the behaviour of the functions under rotations of the coordinate axes and permutations of the three nucleons, yields three S-states functions, four P-state functions and three D-state functions. All ten states are present in $H^3$ if non-central forces exist between nucleons.

539.1

1691. REPULSIVE CORE FORCES IN THE TRITON.
J.M.Blatt and G.Derrick.
Nuclear Phys., Vol. 8, No. 5, 602-6 (Nov. [1], 1958).

A variational calculation is made for $H^3$ with repulsive core forces fitted to two-body data. The binding energy so found increas with increasing core radius.

# NUCLEUS

539.14

1692. RECURRENCE RELATIONS FOR OSCILLATOR-WELL RADIAL INTEGRALS. K.M.Howell.
Proc. Cambridge Phil. Soc., Vol. 54, Pt 4, 475-8 (Oct., 1958).

The general radial integral between oscillator-well wave-functions with a Gauss interaction potential is expressed as a generalized hypergeometric function. A relation between contiguous functions is found and used to obtain a recurrence relation between these integrals.

539.14

1693. A VARIATIONAL PROCEDURE FOR HARD CORE POTENTIALS. K.V.Laurikainen and S.Lyytikäinen.
Nuclear Phys., Vol. 8, No. 4, 416-20 (Oct. [2], 1958).

A variational procedure proposed by Laurikainen and Euranto (Abstr. 6811/1957) for the treatment of the deuteron problem was generalized to include hard-core potentials. Probably the procedure can also be applied if tensor forces and LS-forces are introduced. Numerical results are presented for the case of pure central forces.

539.14

1694. A FORMAL THEORY OF THE OPTICAL POTENTIAL. H.Rollnik.
Z. Naturforsch., Vol. 13a, No. 1, 59-61 (Jan., 1958). In German.

It is proposed to extend the existing formal theory of the localized single-particle potential to include the Pauli principle, by the introduction of a complex potential $\mathcal{V}$. As defined, this symmetrized potential is non-hermitian; the integral-equation system for single-particle operators $\omega_\mu$ is obtained employing the usual formalism due to Watson (Abstr. 2714/1953). S.J.St Lorant

539.14

1695. THE USE OF AN EFFECTIVE THREE-BODY POTENTIAL IN THE NUCLEUS. E.J.Squires
Nuclear Phys., Vol. 8, No. 1, 41-50 (Sept. [1], 1958).

A discussion is given of the possibility of taking into account the state dependence of the Brueckner t-matrix by using an effective potential containing a three-body force. It is shown that this can be chosen so that the binding energy and its density dependence and also the single-particle energies are given correctly. The contribution of the three-body force to the binding energy per particle is shown to be about 17 MeV if the Brueckner and Gammel calculations of the t-matrix are used.

539.14

1696. NUCLEAR MOMENTS OF INERTIA AND EFFECTIVE NUCLEON MASS. D.R.Inglis.
Nuclear Phys., Vol. 8, No. 2, 125-38 (Sept. [2], 1958).

The nuclear moment of inertia may be calculated as the sum of individual-nucleon contributions by treating the dynamics of one sample nucleon in the ellipsoidal harmonic-oscillator potential representing its interaction with the others, on the plausible assumption that the moment of inertia due to all the other nucleons is simply associated with the orientation of the axes of the distortion ellispoid. The ellipsoid is allowed to rotate freely (in two dimensions) with conservation of angular momentum, but the treatment is rather similar to that given earlier on the basis of a constant angular velocity of the ellipsoid ("cranked model"), and the result is the same. The moment of inertia has the rigid value when the magnitude of the distortion of an open-shell nucleus is obtained in the most simple manner, by minimizing the sum of the oscillator energies with constant nuclear volume. The analogous problem of linear translation may be similarly treated. The moments of inertia of highly distorted nuclei are observed to be about half of the rigid value. One might hope to understand this discrepancy in terms of the nucleonic "effective mass" $M_e \approx \frac{1}{2}M$ which appears in some problems involving nucleons passing through nuclear matter, and is required in the shell model to reconcile excitation with binding energies. The shell-model-type assumption considered most plausible is that the effective mass arises from simple dependence of the potential not on the canonical momentum but on the nucleon velocity relative to the axes of the rotating ellipsoid, and this is the assumption whose analogue gives a sensible result in the linear problem. The velocity dependence is taken to be a quadratic one, giving a simple expression for $M_e$. It is shown that, with these assumptions, $M_e$ is not effective for the moment-of-inertia problem and one still obtains the rigid value.

539.14

1697. COLLECTIVE ROTATIONS IN NUCLEI. F.Villars.
Ann. Phys. (New York), Vol. 5, No. 3, 224-42 (Nov., 1958).

A systematic approach is made to the problem of determining the parameters of collective motion in nuclei. Formulae are given for the moment of inertia of the rotational energy and for the collective g-factor of the magnetic moment. These expressions are not based on the use of a model of the nucleus. Such a model will be needed, however, for the numerical evaluation of the expressions derived. The essential elements of a usable model are briefly discussed.

539.14

1698. PHENOMENOLOGICAL THEORY OF NUCLEAR MATTER. P.Mittelstaedt.
Nuclear Phys., Vol. 8, No. 2, 171-90 (Sept. [2], 1958). In German.

A semi-empirical formulation of the independent-particle model for nuclear matter is given. Apart from the energy dependence of the single-particle potential (effective mass), the rearrangement energy is also taken into account. An extension of this theory for real nuclei is shown to be related to the Weizsäcker—Bethe formula and to the optical model for nuclear reactions. The undetermined parameters of the theory are adjusted to fit the corresponding experimental material. The single-particle potentials, the rearrangement energies and the optical potentials for protons and neutrons can then be calculated as functions of the neutron excess. The corresponding data for nuclear matter are obtained by taking equal numbers of protons and neutrons.

539.14

1699. ON THE REARRANGEMENT ENERGY OF NUCLEAR MATTER. P.Mittelstaedt.
Nuclear Phys., Vol. 9, No. 1, 116-23 (Nov. [3], 1958).

The extent to which the rearrangement energy of nuclear matter can be explained by the Brueckner two-body cluster approximation is investigated. Using the formalism of Gomes, Walecka and Weisskopf (see Abstr. 4258/1958), it is shown that the exclusion principle and the requirement of self-consistency lead to a rearrangement energy. The contributions to the rearrangement energy due to higher cluster corrections are discussed by comparing the results so obtained with the phenomenological data. These higher order corrections are found to be relatively unimportant, in disagreement with the critique of the Brueckner theory recently put forward by Hugenholtz and van Hove (see Abstr. 4263/1958).

539.14

1700. EXCLUSION PRINCIPLE AND PHENOMENOLOGICAL OPTICAL-MODEL POTENTIALS.
L.M.Frantz, R.L.Mills, R.G.Newton and A.M.Sessler.
Phys. Rev. Letters, Vol. 1, No. 9, 340-1 (Nov. 1, 1958).

A one-body equation to represent nucleon—nucleus scattering is proposed, in which the exclusion principle is satisfied by choosing the potential to be $\Lambda U + (1-\Lambda)V$. Here V is the complex well seen by the incident nucleon, U is the real well seen by the nucleons bound in the nucleus, and $\Lambda$ projects onto the occupied states of the latter. It is argued that V is a better subject for direct analysis than the resulting effective optical potential.
R.J.N.Phillips

539.14

1701. OPTICAL MODEL OF INELASTIC SCATTERING. T.K.Fowler.
Phys. Rev. Letters, Vol. 1, No. 10, 371-3 (Nov. 15, 1958).

The relationship between the complex optical potential for elastic scattering and that appropriate to the propagation of a nucleon in the nucleus preceding a direct interaction in inelastic scattering is discussed. C.J.Batty

539.14

1702. NON-AXIALLY SYMMETRIC NUCLEI. B.T.Geĭlikman.
Zh. eksper. teor. Fiz., Vol. 35, No. 4(10), 989-91 (1958).
In Russian.

The possibility of the existence of nuclei lacking the axial symmetry is proved for the generalized model.

539.14

1703. EXPERIMENTS WITH THE NEUTRINO. G.Lüders.
Naturwissenschaften, Vol. 45, No. 19, 456-8 (1958). In German.

A historical review of experiments performed with neutrinos; mainly those of Cowan and Reines, and that of Davies.
P.Roman

539.14

1704. COULOMB ENERGIES OF MIRROR NUCLEI. I.Unna.
Nuclear Phys., Vol. 8, No. 4, 468-83 (Oct. [2], 1958).

Coulomb energies of mirror nuclei ($A \leq 45$) are calculated using the harmonic oscillator shell model. Correct isobaric spin wave-functions were used. Nevertheless, the results obtained are very close to those of Carlson and Talmi (Abstr. 447/1955) who used wave-functions of the protons alone. Some formulae of more general interest, obtained during the calculations, are also included.

539.14

1705. NUCLEAR BINDING ENERGIES ON THE STATISTICAL MODEL. N.V.Findler.
Nuclear Phys., Vol. 8, No. 3, 338-57 (Oct. [1], 1958).

An investigation of the binding energies of nuclei by means of the statistical theory is described. A static, charge-independent, scalar meson potential was assumed, and high energy nucleon–nucleon scattering results to limit the parameters occurring in the potential were used. The weight factors obtained for the particular exchange forces are entirely different from the usual values. The mass of the meson used in the theory is close to that of the $\pi$-meson. Also the obtained mesonic charge is reasonable. The binding energies and the nuclear radii are in satisfactory agreement with the known values from $A = 10$ onwards. However, for the very light nuclei, the calculated binding energy is too high. The angular distribution of the differential cross-section for n–p scattering also shows the shortcomings of the assumptions.

539.14

1706. ON THE BINDING ENERGY OF THE $^{16}$O NUCLEUS. II. HIGHER CLUSTERS. J.Dabrowski.
Proc. Phys. Soc., Vol. 72, Pt 4, 499-504 (Oct., 1958).

For previous part, see Abstr. 2519 (1958). The paper contains a calculation of the higher cluster terms neglected in the variational calculation of the binding energy of the $O^{16}$ nucleus given in an earlier paper. All the different contributions to the next term in the Ursell–Jastrow cluster development are calculated with help of an approximation based on the short range of the correlations. The wave-function found in the earlier paper is used. The numerical results show that with the higher cluster terms both binding and density of the $O^{16}$ nucleus are still reproduced by the two-body interaction with the repulsive core radius between 0.2 and 0.6 fermi. The higher cluster terms are found to be of importance in any attempt at quantitative results.

539.14

1707. SPINS OF BISMUTH ISOTOPES OF MASSES 203, 204, 205 AND 206. C.M.Johansson and I.P.K.Lindgren.
Nuclear Phys., Vol. 9, No. 1, 44-8 (Nov. [3], 1958).

The six-pole focusing atomic beam apparatus in Uppsala was used for the measurement of the ground-state spins of four neutron-deficient bismuth isotopes. The experimental results are: for 12 hr $Bi^{203}$, $I = \frac{9}{2}$; for 13 hr $Bi^{204}$, $I = 6$; for 14.5 d $Bi^{205}$, $I = \frac{9}{2}$; for 6.3 d $Bi^{206}$, $I = 6$.

539.14

1708. THE MEASUREMENT OF NUCLEAR SPIN RELAXATION TIMES BY SPIN ECHOES AND INDUCTION DECAYS. H.Pfeifer, H.Winkler and G.Ebert.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 322-30 (1957). In German.

The spin-echo method of measurement of nuclear spin relaxation times ($T_1$ and $T_2$) is described and details of the apparatus given, including circuit diagrams of the pulse generator. Measurements of $T_1$ and $T_2$ in solutions of copper sulphate in water at 23°C are given in the concentration range $10^{17}$ to $10^{21}$ ions per cm$^3$. J.G.Powles

539.14

1709. INDIRECT NUCLEAR SPIN–SPIN INTERACTIONS IN PURE QUADRUPOLE RESONANCE SPECTRA. R.G.Barnes and R.A.Hultsch.
Phys. Rev. Letters, Vol. 1, No. 7, 227-8 (Oct., 1958).

Reports pure nuclear quadrupole resonance spectra of the chlorine nucleus in $TlCl_3$ and $HgCl_2$ in a search for possible effects due to indirect spin–spin coupling between the chlorine nucleus and the heavy nucleus. $Cl^{35}$ resonance in $TlCl_3$ is at 14.756 and 14.812 Mc/s at 24°C with intensity ratio 3 : 2, line widths 2.5 kc/s, no satellite lines, hence $J <\sim 1.25$ kc/s. Corresponding values in $HgCl_2$ are 22.242, 22.061 at 22°C, 2 : 1, 1.2 kc/s and $J <\sim 0.6$ kc/s. Theoretical estimates of J based on the valence bond method support these results. It is concluded that J splitting is not likely to be observed except in "pure" covalent compounds of bromine and iodine. J.G.Powles

539.14 : 538.2

NUCLEAR MAGNETIC RESONANCE SHIFTS IN PARAMAGNETIC $MnF_3$. See Abstr. 1590

539

1710. MAGNETIC MOMENTS OF HIGHLY DEFORMED NUCLEI. J.N.L.Gauvin.
Nuclear Phys., Vol. 8, No. 2, 213-33 (Sept. [2], 1958).

It is shown that the values of magnetic moments of odd-mass nuclei given by the model of independent particles moving in a spheroidal potential well, deviate from the measured values in a systematic way. The sense of this deviation is such that the calculated values lie between the measured values and strong-coupling limits. This behaviour can be understood in terms of a polarization of the core of paired nucleons by virtue of their interaction with the odd nucleon; it is found that this mechanism gives a satisfactory account of the ground-state moments of $Lu^{175}$ and of $Ta^{181}$

539.

1711. CORRELATIONS AND THE NUCLEAR MAGNETIC MOMENT. R.D.Amado.
Phys. Rev., Vol. 111, No. 2, 548-58 (July 15, 1958).

Correlation structure can be introduced into the shell model by means of a product of pair correlation functions, each of which vanishes within the repulsive core radius and then approaches unity with a short range dependent only on the Fermi momentum and the relative energy of the pair. Correlations of this type are independent of the state of a particle within a given shell-model orbit. The additional effect of such scalar, state-independent correlations on the magnetic moment of a "closed-shell plus one" nucleus is shown to vanish, leaving only the shell-model value. The proof can be extended to correlations having a scalar spin dependence and to certain more complicated symmetries. The effect of residual state-dependent correlations due to terms in the relative momentum of the correlated pair and to the space-exchange part of the attraction as appears in the correlations is estimated for $O^{17}$ as a correction to the magnetic moment of 0.002 magneton. There is no modification to the magnetic moment operator due to velocity dependence of the correlation functions, and the expectation value of the ordinary space exchange operator coming from the exchange part of the Hamiltonian is shown to be the same as given by the shell model.

539.

1712. UPPER LIMIT TO THE MAGNETIC MOMENT OF $He^6$. E.D.Commins and P.Kusch.
Phys. Rev. Letters, Vol. 1, No. 6, 208-9 (Sept. 15, 1958).

This upper limit, determined by a Stern–Gerlach type experiment, is 0.16 n.m. It seems highly probable on experimental grounds that the spin of the $He^6$ nucleus is indeed zero. H.Londo

539.1

1713. QUADRUPOLE MOMENT OF $Ne^{21}$. G.M.Grosof, P.Buck, W.Lichten and I.I.Rabi.
Phys. Rev. Letters, Vol. 1, No. 6, 214-15 (Sept. 15, 1958).

The hyperfine-structure intervals in the metastable $(2p)^5(3s)$, $^3$ state of $Ne^{21}$ were measured by the atomic beam resonance method. The quadrupole moment of $Ne^{21}$ is derived from the splitting and is $(+ 0.093 \pm 0.010) \times 10^{-24}$ cm$^2$. L.L.Gree

539.

1714. ON THE CALCULATION OF THE $Y_{40}$ DEFORMATION IN STRONGLY DEFORMED HEAVY NUCLEI. K.Kjällquist.
Nuclear Phys., Vol. 9, No. 1, 163-77 (Nov. [3], 1958).

The equilibrium $Y_{40}$ deformation in strongly deformed heavy nuclei is calculated, treating the $Y_{40}$ term as a small perturbation a spheroidal potential, characterized by a comparatively great $Y_{20}$ deformation. The equilibrium deformation is determined from the condition that the deformation of the potential and of the nuclear density calculated from the wave equation with this potential shall equal. Numerical values are given for even isotopes of Th, U, Pu, Cm, Cf, Fm.

539.14 : 539

GROUND-STATE DOUBLET OF $P^{32}$. See Abstr. 659

539.14 : 539.

BINDING ENERGY OF NEUTRONS IN NUCLEI. See Abstr. 6

539.14 : 539

1715. NUCLEAR MATTER DISTRIBUTIONS FROM COHERENT NEUTRAL PION PRODUCTION. J.E.Leiss and R.A.Schrack.
Rev. mod. Phys., Vol. 30, No. 2(I), 456-61 (April, 1958).

"Nuclear sizes and density distributions" paper. See Abstr.

6217 (1958). The $\pi^0$ production from protons and neutrons being essentially the same, the so-called elastic production in which the target nucleus recoils as a whole in its ground state (or coherent production) determines then the size of the nuclear matter distribution. Experimental results for coherent production on carbon near threshold are described. They indicate that the average distribution of nuclear matter in $C^{12}$ is the same as the electric charge distribution from electron scattering, within 10%. J.Lascoux

539.14

1716. THE DETERMINATION OF THE CHARACTERISTIC VIBRATIONS OF ATOMIC NUCLEI ON THE BASIS OF THE STATISTICAL THEORY OF THE NUCLEUS. D.Kisdi.
Acta phys. Hungar., Vol. 8, No. 4, 387-97 (1958). In German.

The theory of Bloch and Jensen is applied to a nuclear gas. The value $\epsilon = 81.2$ MeV $A^{-1/3}$ is obtained for the excitation energy of the quadrupole vibration, in good agreement with the empirical value. W.A.Hepner

539.14

1717. E2 – M1 MIXING RATIOS IN $2^+ \rightarrow 2^+ \rightarrow 0^+$ TRANSITIONS. V.R.Potnis and C.E.Mandeville.
J. Franklin Inst., Vol. 266, No. 3, 226-8 (Sept., 1958).

Previous measurements of these mixing ratios in some heavy nuclei are re-evaluated. The results conflict with a recent attempt by M.Sakai [unpublished] to correlate their signs and magnitudes systematically in certain regions of neutron number. R.J.N.Phillips

539.14 : 539.163.1

MASS, HALF-LIFE, AND EXCITED STATES OF $B^8$. See Abstr. 601

539.14

1718. EXCITED LEVELS OF NUCLEI WITH MIXED CONFIGURATIONS. I. METHOD OF CALCULATION. Z.Szymański.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 5, 343-8 (1958). Also in: Nukleonika, Vol. 3, Special Number, 18-27 (1958).

It is proposed to calculate excited levels of spherical nuclei in the intermediate mass region by assuming neutrons and protons outside closed shells to be in particular (j–j) subshells, and introducing their mutual interactions as a perturbation. A limitation of this method is mentioned. R.J.N.Phillips

539.14

1719. EXCITED LEVELS OF NUCLEI WITH MIXED CONFIGURATIONS. II. NUMERICAL EXAMPLE. Z.Szymański.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 7, 469-75 (1958).

The method described in Pt I (see preceding abstract) was applied to the case of an even–even nucleus. Four external particles consisting of two protons in $(1p_{3/2})$ states and two neutrons in $(0f_{5/2})$ states are considered and the results of the calculation compared with the experimental level scheme of $Zn^{66}$. L.L.Green

539.14 : 539.163.2

1720. LEVELS AND BRANCHING RATIOS IN $Tb^{159}$. K.O.Nielsen, O.B.Nielsen and O.Skilbreid.
Nuclear Phys., Vol. 7, No. 6, 561-8 (Aug., 1958).

$\beta$-Ray sources of $Gd^{159}$ were prepared in an electromagnetic isotope separator. The decay scheme $Gd^{159} \rightarrow Tb^{159}$ was re-investigated in two six-gap $\beta$-ray spectrometers. $\gamma$-Ray spectra coincident with $\beta$-rays and conversion lines were recorded on a 100 channel analyser. Three $\gamma$-transitions of $\approx 225$, $\approx 300$, and 364 keV from the 364 keV level to the ground state rotational band were observed, and it was confirmed that the relative intensities disagree with the theoretical branching ratios. It is suggested that the deviation is connected with the fact that the $\gamma$-rays are of E1 nature and probably strongly hindered.

539.14

1721. LOW ENERGY LEVELS IN COBALT 60. F.A.El Bedewi and S.Tadros.
Nuclear Phys., Vol. 8, No. 1, 79-84 (Sept. [1], 1958).

The angular distributions of a number of proton groups emitted from the deuteron bombardment of a cobalt target [$Co^{59}(d,p)Co^{60}$] are compared with theoretical curves based on nuclear stripping mechanism. The spins of the ground and first excited levels of $Co^{60}$ are found to be $5^+$ and $2^+$ respectively.

539.14

1722. ROTATIONAL STATES IN EVEN ATOMIC NUCLEI. A.S.Davydov and G.F.Filippov.
Nuclear Phys., Vol. 8, No. 3, 237-49 (Oct. [1], 1958).

A theory of the energy states and the electromagnetic transitions between them is developed for nuclei which do not possess axial symmetry. It is shown that violation of axial symmetry does not significantly change the rotational states of axial nuclei and leads to the appearance of new energy states. The reduced probabilities for E2 and M1 transitions between various rotational states are compared.

539.14

1723. COLLECTIVE EXCITATIONS OF ODD NON-SPHERICAL NUCLEI. A.S.Davydov and B.M.Murashkin.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1619-24 (1958). In Russian.

A theory is developed for the energy states of odd nuclei corresponding to collective nucleon motion in which axial symmetry of the nucleus is not violated. It is shown that the spectrum of the energy states of the nucleus is determined by only two parameters. Conditions under which the energy state spectrum splits up into a system of rotational–vibrational bands are determined.

539.14 : 539.166.83

ENERGY LEVEL SCHEMES OF $Eu^{151, 153}$. See Abstr. 635

539.14 : 539.17

$Sc^{41}$ ENERGY LEVELS. See Abstr. 647

539.14 : 539.17

$Tb^{159}$, $Sm^{152, 154}$ AND Cd ENERGY LEVELS. See Abstr. 653

539.14 : 539.17

ENERGY LEVELS OF $V^{52}$. See Abstr. 657

539.14 : 539.17

NUCLEAR ENERGY LEVELS STUDIED BY NEUTRON INTERACTIONS. See Abstr. 683

539.14

1724. $F^{19}$ IN THE UNIFIED MODEL. G.Abraham and C.S.Warke.
Nuclear Phys., Vol. 8, No. 1, 69-70 (Sept. [1], 1958).

The energies of the $F^{19}$ levels $I = \frac{1}{2}, \frac{5}{2}, \frac{3}{2}$ of positive parity and the magnetic moments of the $\frac{1}{2}$ and $\frac{5}{2}$ levels are calculated with the unified model, assuming weak coupling.

539.14

1725. ON THE CONNECTION BETWEEN DEGENERACY AND ROTATIONAL STATES IN THE NUCLEAR SHELL MODEL. H.J.Lipkin.
Nuclear Phys., Vol. 8, No. 4, 421-7 (Oct. [2], 1958).

A method, applicable in systems where a degeneracy exists between states having different angular momenta, is presented for constructing the collective angle coordinate required for the description of rotational states. It is shown that the collective description can also lead to rotational bands having only a finite number of states.

539.14

1726. DECAY OF HEAVY HYPERFRAGMENT. P.L.Jain.
Canad. J. Phys., Vol. 36, No. 9, 1247-8 (Sept., 1958).

A four-prong secondary star in G5 emulsion exposed at 102 000 ft is interpreted as the non-mesonic decay of either a B or C hyperfragment. E.J.Burge

539.14

1727. THE WAVE FUNCTION OF NUCLEAR MATTER. A.de-Shalit and V.F.Weisskopf.
Ann. Phys. (New York), Vol. 5, No. 3, 282-98 (Nov., 1958).

A two-body correlation amplitude is derived from the Bethe–Goldstone equation. This correlation amplitude is used to construct a wave-function for the A-particle system. It is shown that this wave-function is an approximate eigen-function for the A-particle Schrödinger equation. The correction terms, which all arise from three and more particle correlations, are estimated in terms of the nuclear density.

# RADIOACTIVITY

539.16 : 536.62

USE OF PLUTONIUM OXIDE NEEDLES IN CALIBRATION OF CALORIMETERS. See Abstr. 1389

539.163

1728. NEUTRON-DEFICIENT IRIDIUM ISOTOPES.
R.M.Diamond and J.M.Hollander.
Nuclear Phys., Vol. 8, No. 2, 143-54 (Sept. [2], 1958).

A study was made of the isotopes of iridium which are produced from natural rhenium by irradiations with alpha-particles in the energy range 25 to 45 MeV. The known iridium isotopes of masses 190, 189, and 188 were observed, and in addition $Ir^{187}$, $Ir^{186}$, and $Ir^{185}$ were identified by means of the threshold energy for their production. Analyses are based upon scintillation spectra and conversion electron spectra taken with high-resolution permanent-magnet spectrographs. The interesting situation is encountered in which the three isotopes $Ir^{187}$, $Ir^{186}$, and $Ir^{185}$ all have very similar half-lives; that of $Ir^{187}$ is 13 hours, $Ir^{186}$ 16 hours and $Ir^{185}$ 15 hours. A preliminary study of the radiations from the odd-mass isotopes was made, and also some new transitions in $Ir^{186}$, $Ir^{188}$, and $Ir^{190}$ are reported.

539.163

1729. THE DECAY OF $^{73}Ga$.
C.Ythier, R.K.Girgis, R.A.Ricci and R.Van Lieshout.
Nuclear Phys., Vol. 9, No. 1, 108-15 (Nov.[3], 1958).

The isotope $Ga^{73}$ was produced by fast neutron and deuteron bombardments of natural and enriched germanium; the decay was studied with scintillation and absorption techniques. The half-life is 4.85 ± 0.10 hours; there are two beta branches of 1.19 (94%) and 0.4 (≅ 6%) MeV. Three gamma-rays of 0.295, 0.745 and 1.04 MeV were found, the first one of which is in coincidence with the higher energy beta group. A decay scheme is proposed.

539.163 : 539.18

1730. DISCOVERY OF A NEW MENDELEVIUM ISOTOPE.
L.Phillips, R.Gatti, A.Chesne, L.Muga and S.Thompson.
Phys. Rev. Letters, Vol. 1, No. 6, 215-17 (Sept. 15, 1958).

Helium ion bombardments of $E^{253}$ have resulted in the identification of a new isotope of mendelevium (element 101) with a mass number 255. The isotope decays by orbital electron capture to $Fm^{255}$ with a half-life of approximately ½ hr. The methods used for its production and separation are described. H.C.Cole

539.163.1

1731. STUDY OF $Ir^{191m}$. J.A.R.Cloutier and A.Henrikson.
Canad. J. Phys., Vol. 36, No. 10, 1253-60 (Oct., 1958).

Using the McGill 100 MeV proton synchrocyclotron, the half-life of $Ir^{191m}$ was redetermined and the value 4.53 ± 0.18 sec obtained from 55 trials. The mass assignment is here based on the study of the excitation curves for both osmium and iridium targets. The measured $\alpha_K = 2.0 \pm 0.3$ for the observed 126 ± 6 keV gamma ray is consistent with the M1 + E2 assignment previously made. No 42 keV gamma ray could be detected.

539.163.1 : 539.14

1732. LIFETIME MEASUREMENTS OF THE FIRST EXCITED STATES OF $Tl^{208}$ AND $Ra^{224}$. J.G.Siekman and H.de Waard.
Nuclear Phys., Vol. 8, No. 4, 402-11 (Oct. [2], 1958).

Half-lives $T_{1/2} = (2.6 \pm 1.0) \times 10^{-12}$ sec for the 40 keV state of $Tl^{208}$ and $T_{1/2} = (7.0 \pm 1.0) \times 10^{-10}$ sec for the 85 keV state of $Ra^{224}$ were measured by the line-shift method (Abstr. 2578/1957 and Proceedings of the Rehovoth Conference on Nuclear Structure, Amsterdam: North Holland Publishing Company (1958) p. 571). using extremely thin sources especially prepared for these measurements. The method was checked by determining the latter half-life also from a delayed coincidence measurement, which gave $T_{1/2} = (7.5 \pm 1.5) \times \times 10^{-10}$ sec in good agreement with the first value.

539.163.1 : 539.1.07

THE HALF-LIFE OF $Sm^{147}$. See Abstr. 1639

539.163.2

1733. EXPERIMENTAL EVIDENCE FOR AXIAL VECTOR INTERACTION IN THE DISINTEGRATION OF $Pr^{144}$.
R.L.Graham, J.S.Geiger and T.A.Eastwood.
Canad. J. Phys., Vol. 36, No. 8, 1084-111 (Aug., 1958).

A detailed study of the disintegration scheme of $Pr^{144}$ was carried out using lens spectrometers, scintillation spectrometers, and fast coincidence techniques. The 2293 keV β-component (1.3 studied in coincidence with γ691 has a predominantly first forbidd unique shape and the β−γ directional correlation is strongly anis tropic. The results indicate a probable spin-sequence 0−(β)2+(γ) but the accuracy is not sufficient to exclude completely a 1− assi ment for the $Pr^{144}$ ground state. The β 803 component (1.0%) obse ed in coincidence with γ2181 has an allowed shape and the β−γ directional correlation is isotropic. The shape of the total β-spectrum was studied in a double lens spectrometer having goo anti-scattering properties using sources of $Ce^{144}$ oxide sublimed onto 200 $\mu g/cm^2$ Al leaf. Subtraction of a unique ($B_{ij}$) shape 2293 1.3% component and an allowed shape 803 keV 1.0% component yie the ground state β-spectrum. Analyses were made using the elec tronic functions of Zerianova which assume uniform charge distri bution with $\rho = 1.2\ A^{1/3}\ 10^{-13}$ cm as well as the point charge functi of Rose with $\rho = 1.41\ A^{1/3}\ 10^{-13}$ cm. The observed spectrum shap can be explained on 0− to 0+ selection rules only by the axial vec interaction. Limits on the permissible tensor or pseudoscalar ad mixtures with the axial vector are discussed. No acceptable fit is possible with tensor, pseudoscalar, or any TP admixture (interfer or not) using Rose and Osborn's pseudoscalar formalism.

539.16

1734. β−γ COINCIDENCE SPECTROMETRIC INVESTIGATION OF THE DECAY-SCHEME OF $Nd^{147}$. D.Berényi.
Nuclear Phys., Vol. 8, No. 5, 607-12 (Nov. [1], 1958).

Beta−gamma ray coincidence investigations were carried out by means of a magnetic spectrometer and a NaI:Tl scintillation gamma-ray spectrometer incorporated into the former in order to determine the number and maximum energy of partial beta-ray spectra at the decay of $Nd^{147}$. The following beta-ray groups with end-point energies: 815 ± 10, 529 ± 25, 365 ± 15, and 215 ± 15 ke were found.

539.163.2 : 539.1

BRANCHING RATIOS IN $Tb^{160}$. See Abstr. 1720

539.1

1735. FORM OF THE β-RAY SPECTRA OF $Na^{22}$, $Na^{24}$ AND $P^{32}$
H.Daniel.
Nuclear Phys., Vol. 8, No. 2, 191-8 (Sept.[2], 1958). In German.

The β-ray spectra of $Na^{22}$, $Na^{24}$ and $P^{32}$ were investigated with an iron-free lens spectrometer. The $Na^{22}$ spectrum is found to follow the allowed distribution between 0.16 and 0.47 MeV. The $P^{32}$ spectrum shows a large deviation from the allowed shape. Th deviation is proportional to the electron energy and amounts to $(-4.1 \pm 1.3) \times 10^{-2}/mc^2$. No clear-cut result has been obtained fo $Na^{24}$, but probably there is a small deviation from the allowed sha

539.1

1736. BETA DECAY OF $N^{16}$. D.E.Alburger.
Phys. Rev., Vol. 111, No. 6, 1586-91 (Sept. 15, 1958).

The positron−electron pair coincidence spectrum occurring i the beta decay of 7.4-sec $N^{16}$ was examined at 1.25% resolution wi an intermediate-image pair spectrometer. A line is observed cor responding to internal pair conversion of the 6.14 MeV E3 transiti from the 3− second excited state to the 0+ ground state of $O^{16}$. Th upper limit on the intensity of a 6.06 MeV nuclear pair line from t 0+ first excited state (electric monopole transition) is 10% relativ to the 6.14 MeV line and this corresponds to an upper limit of $1.5 \times 10^{-4}$ for the fractional beta decay to the 6.06 MeV level. A lower limit of 8.2 is derived for the log ft value of this 2− → 0+ be ray branch as compared with the known log ft = 6.7 for the 2− → 0+ 10.4 MeV branch to the ground state.

539.1

1737. ELECTRON POLARIZATION IN THE β-DECAY OF RaE.
W.Bühring and J.Heintze.
Phys. Rev. Letters, Vol. 1, No. 5, 176-7 (Sept. 1, 1958).

The longitudinal polarization of electrons from $Bi^{210}$ (RaE) is determined by measuring the azimuthal asymmetry in scattering after multiple scattering has made the polarization partially trans verse. The result is $\left\langle -cP/v \right\rangle_{Av} = 0.83 \pm 0.02$, an expected deviation from unity for this first-forbidden transitio J.C.Tayl

539.165 : 539.

RECOIL EFFECTS IN β DECAY. See Abstr. 698

539.165

1738. THEORETICAL RESULTS ON ORBITAL CAPTURE.
H.Brysk and M.E.Rose.
Rev. mod. Phys., Vol. 30, No. 4, 1169-77 (Oct., 1958).

Formulae are given for orbital capture transition rates for (ST) and (VA) couplings and for the K, $L_I$, $L_{II}$ and $L_{III}$ subshells. They are given in terms of the relativistic electron wave functions. Numerical values for the wave functions at the nuclear radius are given for Z = 15 to Z = 95. Corrections for finite nuclear size and for screening are given. P.G.Murphy

539.165 : 530.145

EFFECTS OF PTC-NONINVARIANCE IN THE RADIATIVE CAPTURE OF ORBITAL ELECTRONS. See Abstr. 1038

539.165.2

1739. POLARISATION EFFECTS IN BETA DECAY ACCOMPANIED BY INTERNAL BREMSSTRAHLUNG. I.
J.Sawicki and J.Szymański.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 9, 897-903 (1957).

A theoretical treatment on the two-component theory of the circular polarization of the bremsstrahlung and of the longitudinal polarization of the electrons. M.A.Grace

539.165.2

1740. THEORY OF THE $\beta^-$-DECAY OF RHENIUM 187.
N.Gilbert.
C.R. Acad. Sci. (Paris), Vol. 247, No. 12, 868-71 (Sept. 22, 1958).
In French.

The lifetime of $Re^{187}$ is calculated for transition energies around 1 keV. The electron may go into a vacant atomic level, and exchange effects are included. The results are not inconsistent with experiment. J.C.Taylor

539.165.2

1741. EFFECTS RELATED TO NONCONSERVATION OF PARITY IN $\beta$ DECAY.
V.B.Berestetsky, B.L.Ioffe, A.P.Rudik and K.A.Ter-Martirosyan.
Phys. Rev., Vol. 111, No. 2, 522-31 (July 15, 1958).

Angular distributions and polarization of $\beta$-particles are considered on the basis of the most general assumption possible regarding the form of the interaction operator, including effects due to Coulomb field and finiteness of nuclear dimensions. Results are obtained for allowed transitions, first-order forbidden transitions in intermediate and heavy nuclei (Coulomb transitions), unique transitions [$\Delta j$ = 2 (yes)], and 0 → 0 (yes) transitions.

539.165.2

1742. VECTOR INTERACTION IN BETA DECAY.
J.Bernstein and R.R.Lewis.
Phys. Rev., Vol. 112, No. 1, 232-8 (Oct. 1, 1958).

Further experimental consequences of a beta-decay interaction generated by a conserved vector current, as proposed by Feynman and Gell-Mann, are studied. Utilizing the strong analogy between the conserved beta-decay current, and the conserved charge current, higher multipole corrections to the usual results for allowed transitions are computed, and are related to the corresponding electromagnetic transitions, as was first done by Gell-Mann. The effects calculated include corrections to spectra shapes, beta—gamma directional correlations, and beta—alpha directional correlations. A multipole expansion of the V—A interaction is carried out, including all those terms normally classed as allowed and second forbidden. Applications to several interesting transitions are discussed.

539.165.2 : 539.166.2

1743. FIRST ORDER FORBIDDEN $\beta$—$\gamma$-CORRELATION FOR ORIENTED NUCLEI. A.Z.Dolginov and N.P.Popov.
Nuclear Phys., Vol. 7, No. 6, 591-8 (Aug., 1958).

Explicit formulae for $\beta$—$\gamma$ correlation of oriented nuclei in first forbidden $\beta$-transitions are obtained. All five types of $\beta$-interaction are considered and the Coulomb field of an extended nucleus is taken into account. Explicit $\beta$—$\gamma$ correlation formulae for non-oriented nuclei are obtained as a particular case. Angular as well as polarized correlation is considered.

539.166

1744. GAMMA-RAY SPECTRUM OF RADIUM IN EQUILIBRIUM WITH ITS DECAY PRODUCTS. B.S.Dželepow, N.N.Zhukovsky, S.A.Shestopalova and I.F.Uchevatkin.
Nuclear Phys., Vol. 8, No. 3, 250-64 (Oct. [1], 1958).

Results are described of an investigation of the radium gamma-spectrum in equilibrium with its decay products, based on recoil electron measurements in the energy range 150-2530 keV. Forty-four gamma-lines have been observed, and their relative intensities and the number of quanta per disintegration determined.

539.166

1745. DECAY OF $Eu^{152m}$. I.Marklund.
Nuclear Phys., Vol. 9, No. 1, 83-7 (Nov. [3], 1958).

The decay of $Eu^{152m}$ (9.2 hr) is investigated by means of coincidence measurements. The $\gamma$-energies and intensities are measured with a crystal spectrometer and a double-focusing iron-yoke spectrometer. Results: 121.78, 344.3, 841.6, 963.3, 970.3, 1315.0 and 1389.3 keV are discussed in terms of the $Eu^{152m}$ decay scheme.

539.166

1746. DIRECTIONAL CORRELATION OF THE GAMMA RAYS IN $Gd^{154}$. G.D.Hickman and M.L.Wiedenbeck.
Phys. Rev., Vol. 111, No. 2, 539-47 (July 15, 1958).

Directional correlation measurements were carried out on five cascades involving the gamma-rays in $Gd^{154}$. The results of these measurements in conjunction with the worksof Juliano and Stephens, and Cork et al., show the existence of two rotational bands and possibly the start of two more such bands. The nature of these bands are explained in terms of the Bohr—Mottelson model for sphero nuclei. The levels are characterized by the quantum numbers (K, I, $\pi$) and are listed in order of increasing energy. The ground state (0, 0, +) and the first and second excited states of (0, 2, +) and (0, 4, +), respectively. The 0.998 MeV and 1.130 MeV levels are assigned to a second rotational band with K = 2 and spin and parity values 2+, 3+, respectively. The assignment of quantum numbers to the 1.400 MeV level can be made as either (2, 2, ±) with the mixture of (99.5 ± 0.25% D, 0.5 ± 0.25% Q) for the 1.277 MeV gamma-ray or (3, 3, ±) with the mixture of (85 ± 2% D, 15 ± 2% Q) for the 1.277 MeV gamma-ray. The state at 1.723 MeV is best characterized by the quantum numbers (2,2, −) with the mixture of (99.7 ± 0.3% E1, 0.3 ± 0.3% M2) for the 0.725 MeV gamma-ray, or (3, 3, −) with the mixture of (78.5 ± 6% E1, 21.5 ± 6% M2) for the 0.725 MeV gamma-ray.

539.166

1747. GAMMA RAYS FROM $I^{128}$.
H.Bosch, R.Radicella, P.Reyes and T.Urstein.
Phys. Rev., Vol. 111, No. 3, 898-900 (Aug. 1, 1958).

The gamma radiation following the decay of $I^{128}$ was studied by means of a single-channel analyser. Four gamma-rays of energies 0.445, 0.530, 0.740, and 0.975 MeV and relative intensities 100 : 9.3 : 0.9 : 1.8 were found. Three methods of preparing the source were employed in order to check the purity of the sample. Using published data together with these results, a level sequence is proposed for $Xe^{128}$, which is of vibrational type.

539.166.08 : 537.311.33

1748. A SEMICONDUCTING DEVICE FOR DETECTION OF GAMMA-RAYS.
S.M.Rŷvkin, A.P.Bogomazov, B.M.Konovalenko and O.A.Matveev.
Zh. tekh. Fiz., Vol. 27, No. 7, 1601-2 (1957). In Russian.

The dosimeters described consist of disks ~20 mm in diameter whose resistance changes under $\gamma$-irradiation. They are made by evaporating a CdS layer on to a heated conducting substrate (which is one electrode of the final assembly) and then evaporating another conducting layer on top of the CdS to form the second electrode. Values are quoted for currents through typical layers under various intensities of irradiation (applied voltage 10 V). The time constants of the layers are ~15 min at 2 and ~10 sec at 2000 röntgen/hr ($Co^{60}$ $\gamma$-rays). Metallurgical Abstracts

539.166.2 : 539.12

1749. THE ELECTRIC MULTIPOLE RADIATION EMITTED BY A NEUTRON. Tzu Hung-yüan.
Scientia Sinica, Vol. 6, No. 3, 463-6 (June, 1957).

The effect of the anomalous magnetic moment of the neutron on the $\gamma$-ray transition probability according to the single particle model can be described by inserting in the Hamiltonian two terms containing the magnetic and electric field strengths, respectively. The author contends that the matrix element for the neutron transition obtained using both terms is not larger than that calculated from the first term only, contrary to an estimation by Stech. An explicit proof is given for a special case. A.E.I. Research Laboratory

539.166.83

1750. M1 TRANSITIONS IN $^{141}Pr$ AND $^{191}Ir$.
M.C.Joshi, B.N.Subba Rao and B.V.Thosar.
Nuovo Cimento, Vol. 9, No. 4, 600-9 (Aug. 16, 1958).

K-conversion coefficients of the 145 keV transition in $Pr^{141}$ and the 129 keV transition in $Ir^{191}$ were determined to be 0.34 ± 0.035 and 2.1 ± 0.3 respectively. These values are found to be in better agreement with the finite nuclear size corrected values rather than with the point nucleus values.

539.166.83

1751. THE ANGULAR CORRELATION OF MONOPOLE PAIRS OF $Ca^{40}$. S.Gorodetzky, P.Chevallier, R.Armbruster, A.Gallmann and G.Sutter.
Nuclear Phys., Vol. 7, No. 6, 672-6 (Aug., 1958). In French.

The angular correlation of the internal pairs from the first excited level (3.35 MeV) of $Ca^{40}$ obtained in a (p,p') reaction confirms that the transition from this level to the fundamental level $0^+$ has the character of an electric monopole (E0).

539.166.83

1752. ANGULAR CORRELATION OF INTERNAL CONVERSION PAIRS FROM 6.09 MeV LEVEL OF $C^{14}$ AND 5.69 MeV LEVEL OF $N^{14}$. S.Gorodetzky, P.Chevallier, R.Armbruster, G.Sutter and A.Gallmann.
Nuclear Phys., Vol. 8, No. 4, 412-15 (Oct. [2], 1958). In French.

The multipolarities of the 6.09 MeV transition in $C^{14}$ and of the 5.69 MeV transition in $N^{14}$, obtained by bombarding $C^{13}$ with 1.2 MeV deuterons, are determined by measuring the angular correlation of internal conversion pairs. As the resolution of the internal pair spectrometer utilized does not allow one to distinguish between these two transitions, the correlation is studied together for the two transitions, their relative intensities being measured with an external pair spectrometer. The experimental results are compatible only with the spin $J = 1^-$ for the 6.09 MeV level of $C^{14}$ and agree with the value $J = 1^+$ for the 5.69 MeV level of $N^{14}$.

# NUCLEAR REACTIONS

539.17

1753. UNIFIED THEORY OF NUCLEAR REACTIONS. H.Feshbach.
Ann. Phys. (New York), Vol. 5, No. 4, 357-90 (Dec., 1958).

A new formulation of the theory of nuclear reactions based on the properties of a generalized "optical" potential is presented. The real and imaginary part of this potential satisfy a dispersion type relation while its poles give rise to resonances in nuclear reactions. A new derivation of the Breit–Wigner formula is given in which the concept of channel radius is not employed. This derivation is extended to the case of overlapping resonances. These results can then be employed to obtain the complex potential well model for pure elastic scattering. This potential well is shown to become real as the average width of the resonances increases. Reactions as well as elastic scattering are treated. Considering the former process in an isolated resonance, a nonresonant term is obtained analogous to the familiar potential scattering term of elastic scattering. This is just the direct interaction term which thus appears automatically in this formalism. Upon performing the appropriate energy averages over resonances, the complex potential well model is generalized so as to include inelastic scattering. The effects of the identity of nucleons is investigated. It is shown that the present formalism is valid as long as the exit channels can at most contain one nucleon.

539.17

1754. PHENOMENOLOGICAL ANALYSIS OF REACTIONS OF THE $a + a' \rightarrow b + b'$ TYPE.
S.M.Bilenky, L.I.Lapidus, L.D.Puzikov and R.M.Ryndin.
Nuclear Phys., Vol. 7, No. 6, 646-54 (Aug., 1958).

Conditions for the construction from experimental data of the matrix for reactions of the $a + a' \rightarrow b + b'$ type are considered on basis of general principles of quantum mechanics. The reaction matrix M is expanded in a complete set of irreducible tensor operators $T^{JM}(j_b, j_a)$ and the number of complex scalar functions which determine it is computed for the case when invariance under space rotations and reflections is taken into account. Time reversal invariance of the interaction leads to relations between polarization effects in the direct and inverse reactions. The number of experiments required for complete construction of the reaction matrix in the presence of several channels can be determined on basis of unitarity of the S-matrix. The general form of the azimuthal dependence of the angular distribution of the reaction products (for arbitrary spins) is derived in the appendix.

539.17

1755. ON THE ANGULAR DISTRIBUTION OF SHOWER PARTICLES GENERATED IN HIGH-ENERGY NUCLEAR INTERACTIONS. G.Bozóki, E.Fenyves and É.Gombosi.
Nuclear Phys., Vol. 8, No. 2, 199-206 (Sept. [2], 1958).

The differential and intergal angular distributions of shower particles produced in high-energy nuclear interactions are calculated according to the multiple meson production theories of Fermi, Landau and Heisenberg for nucleon–nucleon interaction. Angular distributions calculated according to the theory of Landau are given for nucleon–nucleus interaction too. It is shown by summarizing the experimental data of jets of energies higher than $10^{13}$ eV that the angular distribution alone does not show unambiguously which of the multiple meson production theories, if any, is the correct one.

539.17

1756. ON ANGULAR DISTRIBUTIONS IN COMPOUND NUCLEUS PROCESSES. T.Ericson and V.Strutinski.
Nuclear Phys., Vol. 8, No. 3, 284-93 (Oct. [1], 1958).

The angular anisotropy of particles emitted in compound processes is due to restrictions on the directions of their angular momenta. These restrictions are imposed by the angular momentum distribution of the residual nucleus. The anisotropy is derived in a classical limit.

539.17 : 530.145

1757. PARITY CONSERVATION IN STRONG INTERACTIONS: INTRODUCTION AND THE REACTION $He^4(d,\gamma)Li^6$. D.H.Wilkinson.
Phys. Rev., Vol. 109, No. 5, 1603-9 (March 1, 1958).

A discussion is made of the ways in which parity conservation in ordinary strongly-interacting nuclear systems might be investigated. Three classes of experiment are proposed: in class I one looks for violations of absolute selection rules based on strict parity conservation, which are sensitive to $\mathcal{F}^2$, the intensity of the irregular or parity-nonconserving part of the wave-functions; in class II one looks for longitudinal polarization of product heavy particles or circular polarization of gamma-rays from initially unpolarized systems, which are sensitive directly to $\mathcal{F}$; in class III one looks for odd powers of $\cos\theta$ in the angular distributions or correlations of radiations emitted from well-isolated nuclear states, which are again sensitive to $\mathcal{F}^2$. An experiment of class I is presented, namely a search for the radiative capture $He^4(d,\gamma)Li^6$ through the 0+ state at 3.56 MeV. It is concluded that the heavy-particle width of this state is zero within a standard deviation of 0.2 eV and that this corresponds to $\mathcal{F}^2 < \sim 1 \times 10^{-7}$.

539.17 : 530.145

1758. PARITY CONSERVATION IN STRONG INTERACTIONS: REACTIONS $B^{11}(p,p')B^{11*}_{2.14}$ AND $F^{19}(p,\alpha)O^{16*}_{7.12}$. D.H.Wilkinson.
Phys. Rev., Vol. 109, No. 5, 1610-13 (March 1, 1958).

If parity is strictly conserved, the gamma-rays emitted following the bombardment of unpolarized target nuclei by unpolarized projectiles can show no circular polarization. The author looked for such polarization, using an analyser of magnetized iron, in the 2.14 MeV gamma-ray from the first excited state of $B^{11}$ formed by $B^{11}(p,p')B^{11}$ and in the 7.12 MeV gamma-ray from the fourth excited state of $O^{16}$ formed in $F^{19}(p,\alpha)O^{16*}$. This polarization was expected to be of order $\mathcal{RF}$, where $\mathcal{F}$ is the amplitude of the parity-nonconserving part of the relevant wave-functions and $\mathcal{R}$ is a matrix element factor. It was found that the intensity of circular polarization in the first case is less than $2.0 \times 10^{-3}$ and in the second case $2.0 \times 10^{-3}$. These figures yield $\mathcal{F}^2 < \sim 1 \times 10^{-7}$ and $\mathcal{F}^2 < \sim 3 \times 10^{-8}$, respectively.

539.17 : 530.145

1759. PARITY CONSERVATION IN STRONG INTERACTIONS: REACTION $Li^7(p,p')Li^{7*}_{0.477}$. D.H.Wilkinson.
Phys. Rev., Vol. 109, No. 5, 1614-19 (March 1, 1958).

Unless parity conservation breaks down in strong interactions the radiations emitted from an isolated level cannot display odd powers of $\cos\theta$ in their angular distribution or correlation. A search for such powers is then an approach to the conservation problem. The $\frac{1}{2}-$ first excited state of $Li^7$ at 477 keV was excited by inelastic proton scattering. The expected angular distribution of the gamma-rays of de-excitation relative to the bombarding proton beam is $1 + \alpha\cos\theta$ where $\alpha$ is of order $\mathcal{RF}^2$, $\mathcal{F}$ being the amplitude of the parity nonconserving part of the relevant wave-functions and $\mathcal{R}$ is a matrix element factor. By comparison with the radiation following K-capture in $Be^7$ it is shown that $\alpha$ is zero within a standard deviation of 6 parts in $10^4$. This corresponds to $\mathcal{F}^2 < \sim 1 \times 10$

539.17 : 539.12

1760. EIGENPHASESHIFTS IN TERMS OF WIGNER'S NUCLEAR REACTION THEORY. L.C.Biedenharn and H.B.Willard.
Proc. Phys. Soc., Vol. 72, Pt 5, 874-9 (Nov. 1958).

Eigenphaseshifts and eigenvectors of the nuclear scattering are constructed from the Wigner many-level approximation, after separation of the potential scattering. The two-level case is discussed in detail, and a simple approximation based upon the eigenphaseshift formalism is suggested.

539.17

1761. THE POLARIZATION OF DEUTERONS AND PARTICLES OF ARBITRARY SPIN. L.J.B.Goldfarb.
Nuclear Phys., Vol. 7, No. 6, 622-42 (Aug., 1958).

General formulae are given for the polarization of particles of arbitrary spin which are emitted in a nuclear scattering or reaction process, and also for the angular distribution associated with processes involving incident particles of arbitrary spin that are polarized. These formulae are applied to the particular process of elastic scattering of deuterons by $He^4$ where a narrow resonance is found to exist at the deuteron laboratory energy of 1.069 MeV. This resonance is attributed to a well-defined intermediate state with a unique set of quantum numbers for the initial and final states. In general, the polarization of deuterons is described by tensors of first and second rank; however in this case, the former tensors vanish while the tensors of second rank are independent of the nuclear matrix element and they attain large values for various scattering angles. Thus, the scattering process serves as an efficient polarizer of deuterons. Alternatively, it serves as an efficient analyser of deuteron polarization of rank two.

539.17

NUCLEAR REACTIONS DUE TO COSMIC RAYS. See also the Section entitled "COSMIC RAYS".

539.17 : 539.1.07

1762. INVESTIGATION OF THE $Si^{30}(p,\gamma)P^{31}$ REACTION. INTRODUCTION OF THE SUM-COINCIDENCE METHOD.
A.M.Hoogenboom.
University of Utrecht Dissertation (1958) 111 pp.

$(\gamma,\gamma)$ and $(p,\gamma\gamma)$ correlations were measured using two 4 in. NaI crystals. The pulses from the two counters are added and coincidence is required between the sum peak in the combined spectrum and the two counters. Peak separation is greatly improved and resolution is also improved. Detailed description is given of the mechanical and electronic equipment, including a 70-channel Hutchinson–Scarrott type pulse-height analyser; a nickel ultrasonic delay line is also described. Theoretical correlation coefficients for various mixed and unmixed transitions are discussed. The method was applied to $Si^{30}(p,\gamma)P^{31}$; transitions between five resonance levels with 7.77 to 8.04 MeV excitation (proton energies 500-778 keV) and thirteen levels with up to 5.01 MeV excitation in $P^{31}$ were studied. Spin and parity assignments are given. Relative intensities of the $\gamma$-decay modes are given; $|M|^2$ values for the transitions are discussed in terms of collective nuclear motion. P.G.Murphy

539.17

1763. EMISSION OF A $Li^8$ IN A DISINTEGRATION OF A $C^{12}$ INDUCED BY A 140 ± 6 MeV PROTON.
S.Jannelli and F.Mezzanares.
Atti Soc. Peloritana Sci. Fis. Mat. Nat., Vol. 3, No. 1, 67-71 (1956-57). In Italian.

This event was found in the course of an investigation of disintegrations of emulsion elements by protons from the Harwell cyclotron. The scheme $C^{12} + p \rightarrow Li^8 + He^3 + 2p$ is proposed.
R.H.W.Johnston

539.17

1764. A STUDY OF THE REACTIONS BETWEEN 1 GeV PROTONS AND LIGHT NUCLEI BY A NEW METHOD.
G.Philbert and L.Vigneron.
C.R. Acad. Sci. (Paris), Vol. 247, No. 3, 290-3 (July 21, 1958). In French.

Diluted G4X emulsion was exposed to 1 GeV protons and reactions with light nuclei were studied. Events in which more than two charged particles were emitted were divided into those in which no "slow" particle (proton with energy below 2.25 MeV or $\alpha$-particle with energy below 9 MeV) was emitted and those in which one or more slow particles were emitted. For the events in each of these categories the average number of tracks with grain density in three ranges was obtained. Some interactions with heavy nuclei and the directions of particles giving "black" tracks were also studied.
A.E.I. Research Laboratory

539.17

1765. THE EMISSION OF FAST CHARGED PARTICLES FROM REACTIONS BETWEEN 1 GeV PROTONS AND LIGHT NUCLEI.
G.Philbert and L.Vigneron.
C.R. Acad. Sci. (Paris), Vol. 247, No. 17, 1335-8 (Oct. 27, 1958). In French.

The types of interaction between 1 GeV protons and light nuclei have been classified as $L_1$ and $L_2$ (see preceding abstract). It is shown that for these two processes the energy and angular distribution of emitted fast protons are similar, but that the emission of charged pions is less than for direct nucleon–nucleon interactions.
S.E.Hunt

539.17

1766. PROTON–ALPHA REACTIONS IN LIGHT AND HEAVY NUCLEI. P.E.Hodgson.
Nuclear Phys., Vol. 8, No. 1, 1-12 (Sept. [1], 1958).

Nuclear emulsion was irradiated with 45 MeV protons, and measurements made on the tracks of alpha-particles emitted from disintegrations of the light and heavy nuclei within it. There is a forward excess of energetic alpha-particles in each case, and this can be accounted for by direct interaction processes, for which several possible models are discussed. Conclusions are drawn on the probability of finding alpha-particles in nuclear matter, and on their momentum distribution.

539.17

1767. INVESTIGATION OF THE REACTION $p + p \rightarrow d + \pi^+$ WITH POLARIZED PROTONS OF HIGH ENERGY.
Yu.K.Akimov, O.V.Savchenko and L.M.Soroko.
Nuclear Phys., Vol. 8, No. 6, 637-49 (Nov. [2], 1958).

The angular dependence of the asymmetry in the emission of $\pi^+$-mesons in the reaction $p + p \rightarrow \pi^+ + d$ was measured on a polarized proton beam at energies 536, 616 and 654 MeV. Direct proof of the existence of the d-state of the mesons in the reaction $p + p \rightarrow \pi^+ + d$ was obtained. The results of the experiment are in agreement with the assumption that the amplitudes of the s- and d-transitions are considerably less than the amplitude of the transition $^1D_2 \rightarrow (^3S_1, p)_2$. The limiting values of some partial cross-sections were estimated.

539.17

1768. POLARIZATION PHENOMENA IN NEUTRON–PROTON RADIATIVE CAPTURE. W.Czyz and J.Sawicki.
Nuclear Phys., Vol. 8, No. 6, 621-36 (Nov. [2], 1958).

An analysis of the polarization phenomena in the neutron–proton radiative capture and the photodisintegration of the deuteron is given. The usefulness of some polarization experiments is indicated.

539.17 : 539.12

INELASTIC SCATTERING OF NUCLEONS BY NUCLEI. See Abstr. 1659

539.17 : 539.12

ELASTIC SCATTERING OF PROTONS BY TRITONS AND $He^3$. See Abstr. 1663

539.17

1769. PREDICTIONS OF THE DISTORTED WAVE THEORY OF DEUTERON STRIPPING REACTIONS.
R.Huby, M.Y.Refai and G.R.Satchler.
Nuclear Phys., Vol. 9, No. 1, 94-107 (Nov. [3], 1958).

The distorted wave theory of stripping is presented in a rather general form, and the degree of generality is examined. The spin polarization of (d,p) protons and the correlation function of de-excitation $\gamma$-rays are expressed on this theory as functions of statistical tensors $\rho_{kq}$ which can in principle be calculated given the details of the process (wave functions, interaction potential etc.). The form of the polarization and correlation are investigated, and it is shown what features of these are characteristic of the theory in general as distinct from its details. In this way experimental tests are devised to find whether observed results are compatible with stripping theory of this type. The tests consist in relations predicted between observed "experimental parameters". The cases $l = 1$ and 2 ($l$ = orbital angular momentum of captured nucleon) are discussed fully.

539.17

1770. THEORY OF REACTIONS $H^3(d,n)He^4$ AND $He^3(d,p)He^4$.
W.S.Porter, B.Roth and J.L.Johnson.
Phys. Rev., Vol. 111, No. 6, 1578-85 (Sept. 15, 1958).

These reactions are fitted by using one-level and one-level-plus-background dispersion formulae and taking into account the implications of the principle of charge symmetry of nuclear forces. Fits are found by using a variety of penetration parameters and channel radii. The schematic treatment of Breit and the $\mathcal{R}$-matrix formalism of Wigner and Eisenbud are used to obtain the one-level-plus-background formulae and fits made by using them are compared with those obtained by previous workers using one-level formulae. The connection of these reaction fits with recent $n + He^4$ scattering data is discussed.

539.17 : 539.12

THE (d,t) REACTIONS AND THE INTERNAL STRUCTURE OF THE TRITON. See Abstr. 1689

539.17

1771. THE DISINTEGRATION OF DEUTERONS BY ELECTRONS. M.Suffczyński.
Bull. Acad. Polon. Sci. Cl. 3, Vol. 5, No. 9, 887-9 (1957).

It is shown that the protons from disintegration of deuterons by inelastic scattering of electrons should be considerably polarized. The calculated polarizations depend on the theory assumed for the proton–neutron system, but range up to 28%. S.J.Goldsack

539.17

1772. APPLICATION OF THE STATISTICAL THEORY TO THE REACTIONS OF PHOTODISINTEGRATION. J.Goldemberg.
An. Acad. Brasil. Cienc., Vol. 27, No. 2, 151-65 (1955).
In Portuguese.

A classical approximation is used to obtain, from the basic results of statistical theory, graphs and formulae which may be used directly in calculations concerning photonuclear reactions. L.Pincherle

539.17

1773. STUDY OF THE $(\gamma,\frac{d}{np})$ REACTIONS IN SOME ELEMENTS. S.dos Santos Villaça and J.Goldemberg.
An. Acad. Brasil. Cienc., Vol. 27, No. 4, 427-35 (1955).
In Portuguese.

539.17

1774. THE CALCULATION OF THE PHOTOABSORPTION CROSS SECTION IN $A^{40}$. J.Goldemberg and E.Silva.
An. Acad. Brasil. Cienc., Vol. 30, No. 1, 47-50 (1958).

Photoabsorption in $A^{40}$ is considered separately for the protons and neutrons neglecting spin–orbit coupling and Coulomb barrier effects. Levels are derived from well depths adjusted in each case to give the correct binding energy for the last neutron or proton, and cross-sections for dipole transitions are obtained. The calculated $(\gamma,n)$ and $(\gamma,p)$ cross-sections are found to be smaller than the experimentally observed cross-sections by a factor of ten. A.E.I. Research Laboratory

539.17

1775. $(\gamma,n)$ AND $(\gamma,p)$ REACTIONS IN TITANIUM. E.Silva and J.Goldemberg.
An. Acad. Brasil. Cienc., Vol. 30, No. 1, 51-5 (1958).

Cross-sections for the reactions $Ti^{46}(\gamma,n)Ti^{45}$ and $Ti^{50}(\gamma,p)Sc^{49}$ were determined from threshold up to 22 MeV. The ratio of these cross-sections was compared with the predictions of the statistical theory, and fair agreement obtained. S.J.Goldsack

539.17

1776. RELATIONS AMONG DIFFERENT MODELS OF THE NUCLEAR PHOTOEFFECT. J.S.Levinger.
Nuclear Phys., Vol. 8, No. 4, 428-43 (Oct., 1958).

The collective and shell models of the photoeffect are each idealisations for the complicated behaviour of many overlapping compound states reached by photon absorption, and are not expected to agree in detail. One might, however, find agreement between the mean energies calculated from different models. This agreement in mean energy is found between the two-fluid collective model and the shell model (finite square well approximated as two Fermi gases). There is also agreement between collective and shell-model calculations of the splitting of the giant resonance for deformed nuclei.

539.17

1777. THE NUCLEAR PHOTOEFFECT IN $Al^{27}$. F.Ferrero, R.Malvano, S.Menardi and O.Terracini.
Nuclear Phys., Vol. 9, No. 1, 32-43 (Nov. [3], 1958).

Experimental results concerning the photoneutron cross-sections obtained in different ways. These results are discussed and compared with the predictions of the independent-particle model. Some discrepancies that appeared in previous measurements were clarified, whereas some others still remain unexplained.

539.17 : 539.12

PHOTOPRODUCTION OF $\pi^0$ MESONS AT HELIUM. See Abstr. 1674

539.17

1778. THE LOW ENERGY NEUTRON RESONANCES OF BISMUTH. J.E.Lynn, M.C.Moxon and F.W.K.Firk.
Nuclear Phys., Vol. 7, No. 6, 613-21 (Aug., 1958).

The neutron transmission of bismuth was measured as a function of neutron energy between 300 eV and 4000 eV for samples of different thickness. The analysis of the measurements gives the following parameters. The resonance at 784 ± 9 eV may be described by the combinations of parameters $\sigma_0 a_R^2/\lambda_R^2$ = 5.68 ± 0.22 barn, $\Gamma\lambda_R/a_R$ = 77.4 ± 3.3 eV and the resonance at 2230 ± 40 eV by $\sigma_0 a_R^2/\lambda_R^2$ = 3.78 ± 0.20 barn and $\Gamma\lambda_R/a_R$ = 196 ± 11 eV. The interpretation of these results is that the two resonances correspond to states of the compound nucleus of different total angular momentum J. Hence the effective potential scattering cross-section in the region 0 – 3 keV averages 9.46 ± 0.3 barn. The probable spins of the two resonances are J = 5 for the 784 eV resonance and J = 4 for the 2230 eV resonance and the widths, Γ, are 4.34 ± 0.15 eV and 16.6 ± 0.7 eV respectively. This interpretation implies that the spin of the large resonance observed at about 12 keV by other workers is J = 4 and its width is ≈ 400 eV. The true potential scattering cross-section then turns out to be approximately 10.4 ± 0.3 barn.

539.17 : 539.163

1779. CROSS-SECTIONS FOR (n,p) AND $(n,\alpha)$ REACTIONS OF MAGNESIUM WITH 14.8 MeV NEUTRONS; A NEW ISOTOPE $Na^{26}$. M.J.Nurmia and R.W.Fink.
Nuclear Phys., Vol. 8, No. 2, 139-42 (Sept. [2], 1958).

Irradiation of natural magnesium metal or highly enriched $Mg^{26}O$ with 14.8 MeV neutrons gives rise to a new activity with a half-life of 1.04 ± 0.03 sec which is assigned to $Na^{26}$ from the $Mg^{26}(n,p)$ reaction. The decay appears to proceed mainly by high-energy (> 5 MeV) β-particles. The reaction cross-section is 50 ± 5 millibarns, based on a value of 89 millibarns for the $O^{16}(n,p)N^{16}$ reaction at 14.8 MeV. Simultaneously, the $Mg^{26}(n,\alpha)$ reaction produces well-known $Ne^{23}$ with a cross-section of 89 ± 5 millibarns, based on the $O^{16}(n,p)$ yield. A new measurement of the $Ne^{23}$ half-life gives a value of 38.0 ± 0.3 sec. The cross-section for the $Mg^{25}(n,p)Na^{25}$ reaction is 60 ± 10 millibarns based on the $O^{16}(n,p)$ reaction.

539.17 : 539.12

1780. OPTICAL MODEL OF THE INTERACTION BETWEEN INTERMEDIATE ENERGY NEUTRONS AND NUCLEI. A.V.Lukyanov, Yu.V.Orlov and V.V.Turovtsev.
Nuclear Phys., Vol. 8, No. 3, 325-37 (Oct. [1], 1958).

An optical model of the nucleus is investigated in which a complex potential with a tail expressed by a third degree polynomial is employed. Parameters of the model which give the best fit between the theoretical cross-sections $\sigma_t$, $\sigma_\Gamma$ and $\sigma_s$ and the experimental values for 14 MeV neutrons have been determined. The agreement is quite satisfactory for nuclei heavier than the chromium nucleus. The elastic scattering neutron angular distributions computed with aid of these parameters also satisfactorily agree with experiment. A preliminary investigation at lower energies indicates that in a relatively broad range the parameters depend only weakly on the energy.

539.17 : 539.2

1781. COLD NEUTRON SCATTERING IN BISMUTH. R.C.Bhandari and P.G.Khubchandani.
Phil. Mag. (Eighth Ser.), Vol. 3, 798-800 (Aug., 1958).

A previously noted discrepancy between the total cross-section of cold neutrons in bismuth and the absorption plus the theoretical one-phonon scattering cross-section was attributed to the use of incoherent approximation in the calculation. In this paper, the one-phonon scattering is calculated without incoherent approximation, but the discrepancy between theory and experiment is greater. Contributions from higher-phonon processes would increase the discrepancy further. It is suggested that the cause might be that the frequency spectrum of bismuth is very different from that of the Debye model used in the calculations, particularly at high frequencies contributing appreciably to the scattering cross-section. A.E.I. Research Laboratory

539.17

1782. $U^{236}(n,2n)U^{237}$ CROSS SECTION FROM 6 TO 10 MeV. J.D.Knight, R.K.Smith and B.Warren.
Phys. Rev., Vol. 112, No. 1, 259-61 (Oct. 1, 1958).

Measured with incident neutron energies from 6 to 10 MeV and at 16 MeV. The (n,2n) cross-section at each neutron energy was obtained by multiplying the ratio of $U^{237}$ atoms to fission events, measured radiochemically, by the appropriate $U^{238}$ fission cross-section. These data, together with the data of other investigators for the 13-15 MeV region, are used to outline an (n,2n) cross-section curve from threshold to 16 MeV.

539.17

1783. RADIATIVE CAPTURE CROSS SECTIONS FOR 14.5 MeV NEUTRONS. J.L.Perkin, L.P.O'Connor and R.F.Coleman.
Proc. Phys. Soc., Vol. 72, Pt 4, 505-13 (Oct., 1958).

The radiative capture cross-sections for 14.5 MeV neutrons were measured for some 30 nuclides selected over a wide range of

the periodic table. Chemical procedures were found essential to separate and identify the residual activities arising from capture reactions from the activities caused by the many other competing reactions possible at this neutron energy. Errors due to capture reactions caused by the small percentage of low-energy neutrons, which were unavoidably present during the irradiations, were taken into account. The cross-sections found were of the order of 5 millibarns for all except the lightest of the nuclides examined. A plot of these cross-sections with respect to neutron number indicates relatively low values for the cross-section near magic neutron numbers. These depressions are not so marked as those observed in experiments with fission neutrons. The general level of 5 millibarns found for radiative capture cross-sections for 14.5 MeV neutrons is much higher than the value predicted from some considerations of the theory of the compound nucleus. The consequences of this disagreement are discussed.

539.17 : 539.1.07

CHARGE DETERMINATION OF HEAVY FRAGMENTS FROM NUCLEAR DISINTEGRATIONS. See Abstr. 1642

539.17

1784. DISTRIBUTION OF NUCLEAR CHARGE IN THE PROTON-INDUCED FISSION OF $Th^{232}$.
B.D.Pate, J.S.Foster and L.Yaffe.
Canad. J. Chem., Vol. 36, No. 12, 1691-706 (Dec., 1958).

The cross-sections for the independent formation of $I^{130}$, $I^{131}$, $Te^{131}$, $I^{132}$, and $I^{134}$ and for the cumulative formation of $Te^{132}$, $I^{133}$, and $I^{135}$ in the proton-induced fission of $Th^{232}$ were measured at nine proton energies between 8 and 87 MeV. From these data and from published total chain yield data, charge distribution curves were obtained. These are compared with published charge distribution curves for uranium fission at energies up to 480 MeV and together they show a shift of the most probable fission product charge toward stability and a widening of the distribution with increasing bombarding energy. These phenomena are interpreted in terms of current models for nuclear reactions.

539.17

1785. FISSION OF EXCITED HEAVY NUCLEI. B.D.Pate.
Canad. J. Chem., Vol. 36, No. 12, 1707-19 (Dec., 1958).

The results of published calculations on the prompt nuclear cascade and nuclear evaporation processes are combined with some assumptions regarding the nuclear fission process and fission widths to calculate the average neutron-to-proton ratios of fission products from Th + 8 MeV protons, Th + 87 MeV protons, and U + 450 MeV protons. Comparison of the results with experimental data indicates that the fission charge distribution mode characterized by the equal charge displacement hypothesis, hitherto considered a low energy phenomenon, persists in uranium and thorium up to the highest energy studied. There is also some evidence that fission occurs in excited heavy nuclei before complete de-excitation by particle emission, in agreement with other experimental work.

539.17

1786. MULTILEVEL FORMULA FOR THE FISSION PROCESS.
C.W.Reich and M.S.Moore.
Phys. Rev., Vol. 111, No. 3, 929-33 (Aug. 1, 1958).

The dispersion theory formalism of Wigner and Eisenbud is applied to the problem of interference between resonances in the slow-neutron fission cross-section. The development assumes that the process involves one neutron channel and a large number of channels for the capture process. Although the treatment, for simplicity, assumes that only one fission channel is open, the relevant expressions for the fission cross-section are presented in such a form that the generalization to any number of fission channels is readily apparent. Although no restriction as to the number of levels is necessary, the results are of practical use only when the number of assumed fission channels is small. Multilevel expressions for the radiative capture and scattering cross-sections are also presented for one fission channel. The radiative capture cross-section in the absence of fission is given and shown to differ formally from a sum of single-level Breit—Wigner terms.

539.17

1787. NUMERICAL SOLUTION OF THE TWO-GROUP DIFFUSION EQUATIONS IN X-Y GEOMETRY. R.S.Varga.
I.R.E. Trans Nuclear Sci., Vol. NS-4, No. 2, 52-62 (Dec., 1957).

The two-group diffusion equations describing the reactivity and power distribution of a nuclear power reactor are studied. The problem is treated in two dimensions (Cartesian coordinates). The method of solution by replacement of the differential equations by finite difference equations is outlined. The properties of the resulting matrices are studied in detail. The method of successive over-relaxation is described and the theory developed. The convergence properties of the method and its application is indicated.

539.17

1788. NEUTRON PRODUCTION AND TEMPERATURE IN ZETA.
K.A.George.
Nature (London), Vol. 182, 745-6 (Sept. 13, 1958).

Suggests that the observed neutron yield and ion energies can be explained by runaway ions to be expected if electron—ion collisions are ignored. R.S.Pease

539.17

1789. OAK RIDGE RESEARCH REACTOR.
Nucleonics, Vol. 6, No. 8, chart facing p. 120 (Aug., 1958).

Reactor File No. 6. O.R.R. is a light water-moderated and water-cooled reactor with a heat output of 20 MW. The core has M.T.R. type fuel elements containing 3-4 kg of $U^{235}$. The maximum thermal flux is $3.4 \times 10^{14}$ n/(cm$^2$ sec) and the reactor will be used for irradiation studies (especially of fluid fuels and structural materials), for experiments using external beams and for the production of radioisotopes. R.D.Smith

539.17

1790. THE $\epsilon$-FACTOR IN QUASI-HOMOGENEOUS REACTORS.
W.Oldekop.
Nukleonik, Vol. 1, No. 3, 94-100 (Aug., 1958). In German.

A method, which allowed for the non-thermal fissions below the $U^{238}$ fission threshold, was developed to calculate the fast fission factor $\epsilon$ for quasi-homogeneous reactors. Numerical calculations for uranium-water systems with high uranium content, showed that these non-thermal $U^{235}$ fissions lead to a considerable increase in the $\epsilon$-factor. The results obtained were compared with experimental and other theoretical results, such as those of Chernick. The method can be applied, in principle, to heterogeneous reactors.

D.H.Lord

539.17

1791. A REACTIVITY PROGRAMME FOR CHANGES OF REACTOR OUTPUT. H.Grümm.
Nukleonik, Vol. 1, No. 3, 101-3 (Aug., 1958). In German.

The variations of reactivity, caused by two types of change in neutron content of a reactor n(t), were examined for a single representative group of retarded neutrons. The effect of a linear ramp change of n(t) was solved by Vestergaard's method. A more realistic change of the form

$$n(t) = a + b\,\Phi(ct),$$

where $\Phi$ is the error integral, was also investigated. D.H.Lord

539.17 : 537.56

1792. THE STELLARATOR CONCEPT. L.Spitzer, Jr.
Phys. of Fluids, Vol. 1, No. 4, 253-64 (July-Aug., 1958).

The basic concepts of the controlled thermonuclear programme at Project Matterhorn, Princeton University, are discussed. In particular, the theory of confinement of a fully ionized gas in the magnetic configuration of the stellarator is given, the theories of heating are outlined, and the bearing of observational results on these theories is described. Magnetic confinement in the stellerator is based on a strong magnetic field produced by solenoidal coils encircling a toroidal tube. The configuration is characterized by a "rotational transform", such that a single line of magnetic force, followed around the system, intersects a cross-sectional plane in points which successively rotate about the magnetic axis. A theorem by Kruskal is used to prove that each line of force in such a system generates a toroidal surface; ideally the wall is such a surface. A rotational transform may be generated either by a solenoid field in a twisted, or figure-eight shaped, tube, or by the use of an additional transverse multipolar helical field, with helical symmetry. Plasma confinement in a stellarator is analysed from both the macroscopic and the microscopic points of view. The macroscopic equations, derived with certain simplifying assumptions, are used to show the existence of an equilibrium situation, and to discuss the limitations on material pressures in these solutions. The single-particle, or microscopic, picture shows that particles moving along the lines of force remain inside the stellarator tube to the same approximation as do the lines of force. Other particles are presumably confined by the action of the radial electric field that may be anticipated. Theory predicts and observation confirms that initial breakdown, complete ionization and heating of a hydrogen or helium gas to about $10^6$ degrees degrees K are possible by means of a current parallel to the magnetic field (ohmic heating). Flow of impurities from the tube walls into the heated gas, during the discharge, may be sharply reduced by use of an ultra-high vacuum system; some improvement is also obtained with a divertor, which diverts the outer shell of magnetic flux

away from the discharge. Experiments with ohmic heating verify the presence of a hydromagnetic instability predicted by Kruskal for plasma currents greater than a certain critical value and also indicate the presence of other cooperative phenomena. Heating to very much higher temperatures can be achieved by use of a pulsating magnetic field. Heating at the positive-ion cyclotron resonance frequency has been proposed theoretically and confirmed observationally by Stix. In addition, an appreciable energy input to the positive ions should be possible, in principle, if the pulsation period is near the time between ion–ion collisions or the time required for a positive ion to pass through the heating section (magnetic pumping).

539.17

1793. THE EFFECTIVENESS OF THE CONTROL RODS OF A THERMAL REACTOR. K.H.Beckurts.
Z. Naturforsch., Vol. 11a, No. 10, 881-2 (1956). In German.

The effect of a control rod on the excess neutrons is dependent upon the way in which the rod changes the flux curvature in the reactor. Recently Häfele calculated this change for a cylindrical reactor with a ring of rods about its axis. These results are in good agreement (except for small ring radii) with results obtained from impulse method experiments on a model reactor. D.H.Lord

539.17

1794. ON THE THEORY OF THE HETEROGENEOUS PILE. I. THE PLANE, REGULARLY STACKED PILE. K.Meetz.
Z. Naturforsch., Vol. 12a, No. 9, 698-709 (1957). In German.

As the fuel elements in a heterogeneous pile are arranged regularly, the Wigner–Seitz and homogeneous methods are used to determine the number of neutrons per fission for the lowest eigenvalue and the correct eigenfunction. The accuracy of these methods are investigated and compared. With these results the critical mass and the spatial distribution of the thermal neutron flux can be determined. D.H.Lord

539.17

1795. ON THE THEORY OF THE HETEROGENEOUS PILE. II. DISTURBANCES IN THE PLANE, STACKED PILE. K.Meetz.
Z. Naturforsch., Vol. 12a, No. 11, 863-73 (1957). In German.

The relevant eigenvalue problem is solved exactly for a reactor in which a fuel element was replaced by a layer of some arbitrary material. The solution is based on the results obtained in Pt I (see preceding abstract). A series of examples are evaluated in which the central fuel element is replaced by: a 1 cm layer of Al or Co; a 1.5% or 15% enriched fuel element; a 3 cm layer of uranium absorber. D.H.Lord

539.17

1796. THE IMPORTANCE FUNCTION OF A REACTOR WITH REFLECTOR, USING THE TWO-GROUP-DIFFUSION METHOD. H.Grümm.
Z. angew. Phys., Vol. 9, No. 7, 335-8 (July, 1957). In German.

The critical behaviour of reactors with reflectors is considered using perturbation theory and the importance function; the theory is applied to a small "waterboiler" reactor. A.O.Stanesby

# ATOMS

539.18

1797. APPROXIMATE ANALYTICAL SOLUTION OF THE SCHRÖDINGER EQUATION FOR THE THOMAS–FERMI POTENTIAL FOR THE s STATES. T.Tietz.
J. chem. Phys., Vol. 29, No. 3, 684-5 (Sept., 1958).

The use of an approximate analytic form for the potential, with parameters depending on Z, gives a Schrödinger equation which is analytically soluble, and whose eigenvalues agree well with Latter's numerical solutions of the exact equation. The eigenvalues and eigenfunctions for 1s, 2s and 3s states are given. J.Hawgood

539.18

1798. ANALYTIC WAVE FUNCTIONS. I. ATOMS WITH 1s, 2s, AND 2p ELECTRONS. R.G.Breene, Jr.
Phys. Rev., Vol. 111, No. 4, 1111-13 (Aug. 15, 1958).

Analytic wave-functions are utilized to obtain a general expression for the atomic energy for atoms having one or more electrons in the 1s, 2s, and 2p orbitals. A minimization of this energy expression, containing three independently variable parameters, was programmed on the IBM 704 electronic data processing machine. As an example, this programme was utilized for obtaining the best analytic wave-functions for the single ground configuration of $O^-$ and the three ground configurations of O.

539.18 : 536.71

1799. EQUATION OF STATE OF ELEMENTS FROM THE RELATIVISTIC THOMAS–FERMI THEORY. (CASE OF EXTREME DEGENERACY). V.S.Mathur.
Proc. Nat. Inst. Sci. India A, Vol. 23, No. 5, 430-7 (Sept., 1957).

In this paper, the author has obtained the equation of state of elements at very high pressures from the relativistic Thomas–Fermi equation based on the "density of states" derived by Rudkjøbing (Abstr. 7008/1952). Both extreme relativistic and non-relativistic approximations have been considered. Attention is, however, confined only to the case of "extreme degeneracy". The effect of "exchange" is also neglected as it does not invalidate our results for high pressures and high atomic numbers

539.18

1800. THE $^1$S-STATES OF HELIUM. B.Kockel.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 53-9 (1957). In German.

Binding energy values are calculated from the wave function for the states 1sns $^1$S (n = 2-13) and agree with experimental values to within 2%. Values are also calculated for 2sns $^1$S (n = 3-7).

G.F.Lothian

539.18

1801. EXCITED STATES OF HELIUM. G.Araki.
K. Norske Vidensk. Selsk. Forhandl, Vol. 30, No. 25, 158-64 (1957).

This is an attempt to construct a simple wave-function representing the first excited states, $^3$P and $^1$P, of helium so that, with the help of the observations on fine structure, the "electrodynamic" part of the splitting can be separated out. The best results obtained were (in atomic units):

calculated energies: $-2.13292238$ ($^3$P), $-2.12329785$ ($^1$P)

[cf. observed energies: $-2.132993$ ($^3$P), $-2.123663$ ($^1$P)].

R.O.Davies

539.18

1802. HYPERFINE STRUCTURE OF THE METASTABLE STATE OF SINGLY IONIZED HELIUM-3. R.Novick and E.D.Commins.
Phys. Rev., Vol. 111, No. 3, 822-40 (Aug. 1, 1958).

The h.f.s. splitting $\Delta\nu$ of the metastable state of singly ionized helium 3 is determined by an ion-beam method. The conventional inhomogeneous molecular-beams A and B fields are replaced by radio-frequency fields at 13 350 Mc/s. At this frequency transitions are preferentially induced between the F = 1 component of the $2\,^3S_{\frac{1}{2}}$ state and the short-lived $2\,^2P_{\frac{1}{2}}$ state. All those ions which have made the transition decay immediately to the ground state. Thus, as the beam passes through such a field, state-selection is accomplished by selective quenching of the F = 1 metastable ions. Two types of detection were used: photoelectric detection of the Lyman-alpha photons emitted in the second state selector, and metastable ion detection by the surface Auger effect. Eighty-six determinations of the h.f.s. splitting were made under a range of experimental conditions. The final result is $\Delta\nu = 1083.35499 \pm 0.00020$ Mc/s. This value is compared with the theoretical h.f.s. splitting for a point nucleus, which includes the known electrodynamic, relativistic, and reduced-mass corrections, and which may be computed precisely, since the atomic wave-function of $He^{3+}$ is hydrogenic and known exactly. The observed h.f.s. splitting is smaller by 186 p.p.m. than the theoretical value. This anomaly is attributed to the effect of finite nuclear and nucleon size, higher order radiative effects, and possibly also to nuclear interaction currents. Estimates are made of some of these effects. The h.f.s. splitting $\Delta\nu(1s)$ of the ground state of $He^{3+}$ is estimated on the basis of the present result to be $\Delta\nu(1s) = 8665.628 \pm 0.013$ Mc/s. The experimental result is also compared with the experimentally determined h.f.s. splitting of the 1s2s ($^3S_1$) state of the $He^3$ atom. The ratio of these two quantities yields a precise estimate of the electronic charge density at the nucleus of the $2\,^3S_1$ state of the $He^3$ atom. Finally, the monoenergetic nature of the ion beam allowed observation of a new molecular beams resonance power sharpening effect.

539.18

1803. VARIATIONAL CALCULATIONS OF THE $2\,^3$S STATE OF HELIUM. J.Traub and H.M.Foley.
Phys. Rev., Vol. 111, No. 4, 1098-108 (Aug. 15, 1958).

With a 12-parameter Hylleraas-type wave-function containing only positive powers, a new calculation is carried out for the $2\,^3$S state of helium by the Ritz variational principle. The energy was minimized by a descent process. A nonrelativistic energy of $-1.0876088$ Hylleraas units was reached as compared with the best previously published value of $-1.0876015$ Hylleraas units from a 6-parameter function. When mass-polarization and $\alpha^2 R_y$ correction

are included, the 12-parameter function gives an ionization potential 2.52 $cm^{-1}$ less than the experimental value of 38 454.64 $cm^{-1}$. The electron density at the nucleus is also calculated and compared with the experimental hyperfine-spectrum value. All numerical work was carried out on an I.B.M. 650 computer.

539.18

1804. THE HYPERFINE STRUCTURE OF THE GROUND STATE OF EUROPIUM. K.Krebs and R.Winkler.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 60-9 (1957). In German.

The hyperfine spectrum of europium was examined experimentally using a Fabry—Perot interferometer in conjunction with a Steinheil three-prism spectrograph. A graphical method of analysis is described for determining the various hyperfine-structure terms, which are tabulated for $Eu^{151}$ and $Eu^{153}$. The splitting factor is found to be $-0.93 \pm 0.05$ mK, confirming the independent determination of Brix (Abstr. 118/1953). J.W.Gardner

539.18 : 535.331

1805. LOW EVEN CONFIGURATIONS IN THE FIRST SPECTRUM OF RHENIUM (Re I). R.E.Trees.
Phys. Rev., Vol. 112, No. 1, 165-71 (Oct. 1, 1958).

The theory of intermediate coupling with configuration interaction is used to calculate energy levels and g values in the $5d^56s^2$ and $5d^66s$ configurations of Re I. Fifty-one observed levels are fitted with a mean deviation of $\pm 325$ $cm^{-1}$ by using eleven free parameters. The L(L+1) correction is important, as the mean deviation is $\pm 514$ $cm^{-1}$ without it; the parameter for this correction ($\alpha = 66.8 \pm 13$) has a value similar to that in first and second long-period spectra. Standard deviations of the parameters are calculated, and within the limits so defined, Slater's parameters are consistent with expectations based on known behaviour in first and second long-period spectra. Calculated g values agree with observed values for thirty-seven levels to about $\pm 0.03$. Levels not previously assigned from experiment are given designations; the eigenvectors are used to illustrate qualitative features of these designations.

539.18

1806. ON ISOTOPE SEPARATION BY DISTILLATION.
G.Richter.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 45-52 (1957). In German.

It is shown that there is a significant increase in separation effect in a distillation column when throughput variations are reduced by the "buffer" effect of the liquid holdup. The problem of the regulation of distillation with small separation factors is simplified by this means. H.C.Cole

539.18

1807. AN ELECTROMAGNETIC ISOTOPE SEPARATOR.
J.Muto and K.Okano.
Mem. Coll. Sci. Univ. Kyoto A, Vol. 28, No. 4, 337-62 (May, 1958).

A medium sized electromagnetic separator (magnet weight 7 tons) constructed at Kyoto University has been in operation since September 1956. The main features of the machine are described and experiments on source efficiency, resolving power, and space charge effects are discussed. Details of the separation of the isotopes of Mg, Ne and Si are given, each of which requires a different technique in preparing the ion source. H.C.Cole

539.18 : 539.163

DISCOVERY OF A NEW MENDELEVIUM ISOTOPE. See Abstr. 1730

539.18

1808. BROKEN ATOMIC BEAM RESONANCE EXPERIMENT.
D.Kleppner, N.F.Ramsey and P.Fjelstadt.
Phys. Rev. Letters, Vol. 1, No. 7, 232-3 (Oct. 1, 1958).

The separated oscillatory field resonance method can be extended to cases in which the beam collides with other atoms, or suitable solid surfaces, between the two fields. Evidence of transitions from hyperfine F = 4, M = 0 states to F = 3, M = 0 states was obtained using eicosane, polyethylene, and heated Teflon. P.Gray

539.18

1809. DETERMINATION OF THE CROSS-SECTION OF THE TRANSITION $6^3P_1—6^3P_0$ OF MERCURY FOR COLLISIONS WITH THE NITROGEN MOLECULE. G.Laroze and J.L.Cojan.
C.R. Acad. Sci. (Paris), Vol. 247, No. 14, 995-8 (Oct. 6, 1958). In French.

The cross-section for the collision de-excitation Hg ($6^3P_1 \rightarrow 6^3P_0$) by nitrogen was studied as a function of pressure and found to be about 20 $A^2$, from 0 to 100 mm Hg. R.W.Nicholls

539.18

1810. COMPARISON OF THEORETICAL AND EXPERIMENTAL ELECTRON COLLISION CROSS SECTIONS FOR THREE EXCITATIONS IN HELIUM. S.M.Silverman and E.N.Lassettre.
J. chem. Phys., Vol. 29, No. 4, 891-4 (Oct., 1958).

A comparison of theoretical and experimental electron collision cross-sections is made for transitions from the ground state of the helium atom to the $2^1S$, $2^1P$, and $3^1P$ excited states

539.18

1811. ELECTRON EXCITATION OF ATOMIC HYDROGEN IN THE 2s STATE. T.J.M.Boyd.
Proc. Phys. Soc., Vol. 72, Pt 4, 523-31 (Oct., 1958).

Using an interpolation procedure the Born approximation to the cross-sections for the excitation of hydrogen atoms from the 2s-state to the eighth and higher levels was obtained from computed cross-sections for transitions to the lower discrete levels and to the continuum. An incident energy range of from 5 eV to 120 eV is covered.

539.18 : 539.12

1812. ON THE USE OF THE ADIABATIC THEORY IN ELECTRON—ATOM COLLISION CALCULATIONS.
V.M.Martin, M.J.Seaton and J.B.G.Wallace.
Proc. Phys. Soc., Vol. 72, Pt 5, 701-10 (Nov., 1958).

The adiabatic theory allows for perturbation of the atom by treating the colliding electron as a fixed point charge. The form of the wave-functions obtained may be shown to be correct in the limit of large separations. Numerical results are discussed for the s- and p-phases in electron—hydrogen collisions. It is considered that the adiabatic theory over-estimates the effect of perturbations of the atom for separations of order of one atomic unit. The error introduced for the s-wave may be particularly large.

539.18

1813. THE EXCITATION OF HELIUM BY ELECTRONS OF LOW ENERGY. S.J.B.Corrigan and A.von Engel.
Proc. Phys. Soc., Vol. 72, Pt 5, 786-90 (Nov., 1958).

An analysis was made of the main excitation processes caused by an electron swarm passing through helium. Recent experimental studies of energy losses of monoenergetic electron beams in helium together with published theoretical excitation functions were used to obtain approximate cross-sections for the principal transitions leading to metastable and resonance states. The energy balance for an electron swarm in helium is derived and compared with that found previously for molecular hydrogen.

539.18 : 536.46

CYCLOTRON RESONANCE IN FLAMES. See Abstr. 1377

539.18 : 537.564

CHARGE TRANSFER OF PROTONS IN EXCITED ATOMIC HYDROGEN. See Abstr. 1562

539.18

1814. OPTICAL POLARIZATION OF ATOMIC HYDROGEN.
L.W.Anderson, F.M.Pipkin and J.C.Baird, Jr.
Phys. Rev. Letters, Vol. 1, No. 7, 229-30 (Oct. 1, 1958).

Describes an experiment in which H atoms were produced in an atmosphere of optically oriented Na atoms, which oriented the H atoms by collision, enabling the low-field Zeeman and hyperfine transitions of H to be detected by the change in the opacity of the Na when a radiofrequency field disoriented the H atoms. It is suggested that the method could be refined and used to re-measure the zero-field hyperfine splittings for hydrogen, deuterium and tritium. J.Hawgood

# MOLECULES

539.19

1815. QUANTUM-MECHANICAL CALCULATION OF ONE-ELECTRON PROPERTIES. I. GENERAL FORMULATION.
M.Karplus, A.Kuppermann and L.M.Isaacson.
J. chem. Phys., Vol. 29, No. 6, 1240-6 (Dec., 1958).

For a one-electron operator, general formulae for weighted transition functions, weighted density functions and their integrals are introduced. A detailed treatment is given of the expressions that are obtained from these formulae when they are applied to a system whose wave-functions are expanded in a series of determinants of one-electron spin orbitals. Explicit consideration is given to the nonorthogonality problem and a method for the exact

inclusion of overlap terms is formulated. The simplifications resulting from the use of the single determinant approximation and orthonormal functions are discussed. A brief evaluation of the suitability of the formulation for digital computer calculation is given.

539.19

1816. CALCULATION OF THE ENERGIES OF TRIATOMIC HYDROGEN USING A MODIFIED ROOTHAAN PROCEDURE. W.E.Meador, Jr.
J. chem. Phys., Vol. 29, No. 6, 1339-45 (Dec., 1958).

Potential energies for some linear, symmetrical configurations of $H_3$ are calculated using a modified Roothaan procedure with configuration interaction, and including a variable shifting parameter. Calculations for two excited states are also given along with detailed discussions of the various energy functions. The results are found to be very close to those obtained by Hirschfelder, Eyring, and

539.19

1817. EVALUATION OF FORCE CONSTANTS OF PLANE $XY_3$ MOLECULES FROM VIBRATIONAL DATA. C.W.F.T.Pistorius.
J. chem. Phys., Vol. 29, No. 5, 1174-6 (Nov. 1958).

All five force constants of the most general harmonic potential field are evaluated for 4 molecules and 4 ions of the plane $XY_3$ type (symmetry group $D_{3h}$) by means of Wilson's F–G matrix method. In the cases where no isotopic data are available, this is made possible by the introduction of an approximation from Heath and Linnett's OVFF treatment. Semiquantitative corrections are made for anharmonicity and for the produce rule wherever possible.

539.19

1818. POTENTIAL FIELD AND FORCE CONSTANTS OF OCTAHEDRAL MOLECULES. C.W.F.T.Pistorius.
J. chem. Phys., Vol. 29, No. 6, 1328-32 (Dec., 1958).

The force constants of 10 molecules and 5 ions of the type $XY_6$ belonging to the $O_h$ symmetry are calculated from the observed frequencies by Wilson's F–G matrix method, using Raman and infrared data. Although only one force constant is neglected, imaginary results were found in the cases of $MoF_6$ and $WF_6$. Possible causes for this are discussed.

539.19

1819. ROTATIONAL ANALYSIS OF THE $\gamma$ SYSTEM OF THE PO MOLECULE. K.Suryanarayana Rao.
Canad. J. Phys., Vol. 36, No. 11, 1526-35 (Nov., 1958).

The bands of the $\gamma$ system of the PO molecule were photographed under high dispersion (0.35 A/mm). A rotational analysis of the 0–0, 0–1, and 1–0 bands is given, which differs from the one previously given by Sen Gupta. In addition, four more bands, namely, the 1–2, 2–1, 2–3, and 2–4 bands, are analysed. The bands are attributed to the electronic transition, $A^2\Sigma - X^2\Pi_{reg}$, the lower state being the ground state of the molecule. The new rotational constants for the ground state are the following:

$$B_e = 0.7331\ cm^{-1};\ a_e = 0.0055\ cm^{-1};\ r_e = 1.473_0\ A;\ A \sim 224\ cm^{-1}.$$

The spin doubling in the upper state is small. Perturbations in the v = 0 level of the upper state, which were not reported previously, are observed and discussed. They supply a confirmation of the correctness of the analysis.

539.19 : 541.183

1820. HINDERED ROTATION IN ADSORBED HYDROGEN. ADIABATIC COOLING BY ADSORBED PARAHYDROGEN. Y.L.Sandler.
J. chem. Phys., Vol. 29, No. 1, 97-9 (July, 1958).

Hindrance to rotation of hydrogen molecules in the adsorbed state is discussed. The possibility is pointed out that in some cases the lowest para-level may lie close to the lowest ortho-level. It is proposed that a simple adiabatic cooling method be obtained by allowing adsorbed parahydrogen to convert to equilibrium hydrogen at low temperatures under adiabatic conditions. It is shown that very low temperatures might be obtained under favourable conditions by relatively simple means.

539.19 : 535.343

1821. TRIATOMIC LINEAR MOLECULES CONTAINING CARBON AND OXYGEN, SULFUR, SELENIUM, OR TELLURIUM. I. VIBRATIONAL SPECTRA OF $CS_2$, $CSe_2$, SCSe, AND SCTe. T.Wentink, Jr.
J. chem. Phys., Vol. 29, No. 1, 188-200 (July, 1958).

The vibrational infrared absorption spectra of the molecules $CSe_2$, SCSe, and SCTe have been recorded and analysed. Some Raman data are also reported. The fundamental frequencies (in $cm^{-1}$) of these molecules, $\sigma_1$ (symmetric stretching), $\sigma_2$ (bending), and $\sigma_3$ (asymmetric stretching) are, respectively: $CSe_2$ (gas) 368, 308, and 1303; $CSe_2$ (liquid) 368, 310, and 1267; SCSe (g) 506, 355, and 1435; SCSe (l) 502, 350, and 1408; SCTe ($CS_2$ solution) 423, 337, and 1347. Observed isotopic shifts due to $C^{13}$ in all three compounds are reported and discussed. The expected linearity of $CSe_2$ is confirmed. The synthesis and purification of the more unstable members of the $CX_2$-XCZ family (X,Z = O, S, Se, or Te) are discussed. Some predictions, of possible use in identification, for the intense fundamental $\sigma_3$ of the so far unreported and probably very unstable OCTe, SeCTe, and $CTe_2$ are made. These are based on a treatment using a uniform potential energy function for all these molecules.

539.19

1822. VIBRATION-ROTATION BANDS OF AMMONIA. III. THE REGION 3.2-4.3 MICRONS. W.S.Benedict, E.K.Plyler and E.D.Tidwell.
J. chem. Phys., Vol. 29, No. 4, 829-45 (Oct., 1958).

For Pt II, see Abstr. 4375 (1958). The weak absorption of $NH_3$ between 2373-3080 $cm^{-1}$ was studied under high resolution, and a complete analysis given for over 1000 lines, including studies of the intensity and line width. The strongest bands ($S_V^0$ = 0.44 and 0.20 $cm^{-2}$ $atm^{-1}$, respectively) are $3\nu_2^s - 0^a$ and $3\nu_2^a - 0^s$; $\nu_3 - \nu_2$ ($S_V^0$ = 0.074); $\nu_3 + \nu_2 - 2\nu_2$ ($S_V^0$ = 0.011); and $\nu_2 + \nu_4$ ($S_V^0$ = 0.06) have also been located. $\nu_2 + \nu_4$ shows anomalous intensity behaviour as well as large vibration-rotation-inversion-$\zeta$-splitting interactions. The lines in $3\nu_2$ are 40-50% narrower than those in the microwave region, and appear symmetrical with no pressure shifts.

539.19

1823. PERPENDICULAR BANDS OF ALLENE AND ALLENE-$d_4$. J.Overend and B.Crawford, Jr.
J. chem. Phys., Vol. 29, No. 5, 1002-11 (Nov., 1958).

The distribution of intensity in the perpendicular bands of allene is examined, taking into account the effect of the Coriolis interaction between the degenerate levels $\nu_9$ and $\nu_{10}$. The results indicate that in all the perpendicular bands of allene and allene-$d_4$ the $^RQ_0$ branch lies on a line which divides the band into two equal (or very nearly equal) areas. This is used as a criterion for a new rotational assignment of these bands and the rotational constants A and $\zeta$ are re-evaluated. The present A values, together with Stoicheff's B values indicate that the CH bond length is 1.061 A and the HCH angle 116°.

539.19

1824. VIBRATIONAL INTENSITIES. X. INTEGRATION THEOREMS. B.Crawford, Jr.
J. chem. Phys., Vol. 29, No. 5, 1042-5 (Nov., 1958).

For Part IX, see Abstr. 9082 (1958). The advantages of integrating absorption intensities against the logarithm of the frequency, rather than against the frequency itself, are presented.

539.19

1825. AN ANTIBONDING MORSE POTENTIAL. R.W.Keyes.
Nature (London), Vol. 182, 1071-2 (Oct. 18, 1958).

The conventional Morse potential may be regarded as an approximation to the potential curve for nuclear motion for $H_2^+$ in its ground state, so that by analogy the curve for the antibonding state of $H_2^+$ leads to an antibonding Morse potential, obtained from the usual one by reversing the sign of the attractive part, using the same parameter values. The concept works well, and may be generalized to give a successful relation between the vibrational frequencies and the lengths of different states of the same bond (e.g. C–N, C–O) in a series of molecules. J.Hawgood

539.19

1826. SOME TWO-CENTER OVERLAP INTEGRALS WITH AO's OF PRINCIPAL QUANTUM NUMBER FOUR. L.Leifer, F.A.Cotton and J.R.Leto.
J. chem. Phys., Vol. 28, No. 2, 364-5 (Feb., 1958).

These were obtained by the methods of Mulliken, Rieke, Orloff and Orloff (1949), and the tabulated results have been deposited with the Library of Congress. J.Hawgood

539.19

1827. PI-ELECTRON CORRELATION IN THE POLYENES. M.J.S.Dewar and C.E.Wulfman.
J. chem. Phys., Vol. 29, No. 1, 158-61 (July, 1958).

The study of electron correlation by the determination of configurations of maximum probability is extended to molecular problems in an investigation of the ground states of the first four polyenes. The correlation among pi electrons of the sam spin is such

that they are most likely to be found near the midpoints of the classical double bonds. Reasons are adduced for extending this result to all the pi electrons, irrespective of spin, and a simple wave-function implying this is investigated and shown to give good pi electron energies.

539.19

1828. SEMIEMPIRICAL CALCULATION ON THE ELECTRONIC STRUCTURE OF THE NITROGEN-CONTAINING HETEROCYCLIC MOLECULES. I. GENERAL THEORY. T.Anno.
J. chem. Phys., Vol. 29, No. 5, 1161-9 (Nov., 1958).

A semiempirical theory for n—$\pi$ and $\pi$—$\pi$ spectra of nitrogen heterocycles is proposed. The theory is an extension of the semiempirical molecular-orbital method of Pariser and Parr, and the nonbonding electrons localized at the nitrogen atoms as well as $\pi$ electrons are considered explicitly into the interaction term in the Hamiltonian. The orbitals in which nonbonding electrons are contained may be any 2s—2p hybrids. The differential overlap between atomic orbitals are formally neglected. One-centre electronic-interaction integrals are obtained from atomic spectral data and two-centre integrals at moderate internuclear distances are extrapolated, using corresponding one-centre integrals obtained from atomic spectral data together with the theoretical value of the two-centre integrals at larger internuclear distances. On account of the hybrid nature of the nonbonding AO's (AO's from which nonbonding MO's are constructed), various kinds of two-centre integrals as well as one-centre ones appear. The method of obtaining these integrals is described systematically. The method of obtaining the valence-state ionization potential for nonbonding electrons in hybrid orbitals is also described. Finally, as an example of the application of the present scheme, the energy levels of the pyrazine molecule are calculated, assuming that the s character of the nonbonding AO at the nitrogen atom is one third and taking account only of interactions among the ground and the singly-excited configurations. Only the singlet levels are considered in this paper. Although the calculated $^1A_g \rightarrow {}^1B_{3u}(\pi-\pi)$ transition energy agrees fairly well with experiment, it is found for $^1A_g \rightarrow {}^1B_{1u}$, $^1B_{3g}(n-\pi)$ transitions that the calculated values are considerably higher than the observed values. This is probably due either to the neglect of the doubly excited configurations or to the invalid assumption concerning the hybridization parameter of the nitrogen nonbinding AO.

539.19

1829. SEMIEMPIRICAL CALCULATION ON THE ELECTRONIC STRUCTURE OF THE NITROGEN-CONTAINING HETEROCYCLIC MOLECULES. II. ELECTRONIC STRUCTURE OF PYRAZINE WITH PARTICULAR REFERENCE TO ITS n—$\pi$ TRANSITION.
T.Anno and A.Sadō.
J. chem. Phys., Vol. 29, No. 5, 1170-3 (Nov., 1958).

The doubly excited configurations as well as singly excited configurations are considered in CI calculation. It is shown that the usual assumption of $sp^2$ hybridization of the nonbonding orbital of the nitrogen atoms in the pyrazine molecule results in a considerably higher calculated value for the n—$\pi$ transition energy as compared with experiment, even if the doubly excited configurations are considered. In order to bring the calculated values of the lowest $^1A_g \rightarrow {}^1B_{1u}$, $^1B_{3g}$ (n—$\pi$) transition energies in agreement with the observed values, the s character of the nonbonding orbital of the nitrogen atom should be taken as 0.103. Discussions which support the lower s character of the nonbonding orbitals of the nitrogen atoms in this molecule are presented.

539.19

1830. TWO-CENTRE INTEGRALS ARISING OUT OF 2s AND 2p ATOMIC FUNCTIONS. A.Rahman.
Mem. Acad. Roy. Belgique Cl. Sci. (Coll. in 4°), Vol. 14, No. 2, 13 pp. (1955).

Tabulates electron-repulsion and overlap integrals between all molecular wave functions of g and u symmetry, formed from 2s and 2p Slater orbitals with the same exponent, for values 1.0(0.5)7.0 of the product of the exponent and the internuclear distance. The integrals tabulated are the ones which appear as matrix elements, and are calculated as linear combinations of the elementary integrals tabulated by Kopineck (1950-52). J.Hawgood

539.19 : 530.145

ON THE APPROXIMATE CALCULATION OF EIGENFUNCTIONS.
See Abstr. 1088

539.19

1831. NUCLEAR RESONANCE STUDY OF STRUCTURE AND MOLECULAR MOTIONS IN SOME COBALT COMPLEX SALTS.
G.R.Murray, Jr and J.S.Waugh.
J. chem. Phys., Vol. 29, No. 1, 207-13 (July, 1958).

Line widths and second moments of the proton and $F^{19}$ resonances in $Co(NH_3)_6X_3$ (X = Cl, Br, I, $NO_3$, $BF_4$, $PF_6$) were measured from 90° to 400°K. In the first four, unusual and very broad (~ 200°K) line-width transitions were observed. These are interpreted by postulating crystal structures containing nonequivalent sites for $Co(NH_3)_6^{+++}$ ions in relative abundances 2 : 1, 1 : 1, 1 : 1, and 2 : 1, respectively. This interpretation was verified in one case by X-ray diffraction. $Co(NH_3)_6(BF_4)_3$ showed a normal line-width transition which is interpreted both by the usual correlation theory and by a very detailed analysis to give $\Delta E \cong 12$ kcal/mole and $\tau_0 \cong 10^{-14}$ sec. At 90°K rapid reorientation of $-NH_3$ groups and of $BF_4^-$ and $PF_6^-$ ions occurs in all of these salts. At 330°K and above, rapid tumbling of $Co(NH_3)_6^{+++}$ ions occurs.

539.19

1832. LINE WIDTH OF THE PURE QUADRUPOLE RESONANCE OF CHLORINE IN SODIUM CHLORATE. T.Fuke and Y.Kôi.
J. chem. Phys., Vol. 29, No. 4, 973-4 (Oct., 1958).

Reports experimental second moments of absorption lines for the $Cl^{35}$ and $Cl^{37}$ pure quadrupole resonances in single crystals of sodium chlorate. The absorption only varies slightly between 0°C and liquid air temperatures. The experimental results agree satisfactorily with theoretical values based on the assumption that the broadening is entirely due to dipole—dipole interaction.
J.G.Powles

539.19

1833. CALCULATION OF NUCLEAR MAGNETIC RESONANCE SPECTRA OF AROMATIC HYDROCARBONS.
C.E.Johnson, Jr and F.A.Bovey.
J. chem. Phys., Vol. 29, No. 5, 1012-14 (Nov., 1958).

The free electron model of Pauling is used to calculate the magnetic field around a benzene ring which is rotating rapidly about all axes in an external magnetic field. It is assumed that the $\pi$ electrons precess in two circular paths, one on each side of the ring, equal in radius to the C—C distance in the benzene ring. The separation of these rings is taken as 1.28 A, which gives a calculated value for the nuclear magnetic resonance shielding value for benzene protons equal to the observed value. The field thus calculated is employed to predict shielding values for other aromatic compounds. Agreement with experiment is in general good, but there are some exceptions.

539.19

1834. $N^{14}$ QUADRUPOLE INTERACTION WITH AN ASYMMETRIC FIELD GRADIENT. P.A.Casabella and P.J.Bray.
J. chem. Phys., Vol. 29, No. 5, 1105-7 (Nov., 1958).

$N^{14}$ pure quadrupole resonances were found in three compounds having a nonzero asymmetry parameter for the electric field gradient at the resonating nuclei. The shapes of these resonances demonstrate a decrease in the effectiveness of Zeeman modulation as the asymmetry increases, in agreement with theory.

539.19

1835. EVALUATION OF TWO-CENTER EXCHANGE INTEGRALS. G.E.Tauber.
J. chem. Phys., Vol. 29, No. 2, 300-10 (Aug., 1958).

The evaluation of two-centre exchange integrals for any homonuclear molecules using Slater-type wave-functions is reduced to the solution of Poisson's equation. An expression is obtained for the exchange integrals in terms of integrals which can be evaluated analytically. In particular, all cases which arise from 2s and 2p wave-functions are discussed in detail and the auxiliary integrals evaluated. The pertinent results are collected in tables, and the final result for a particular exchange integral is given explicitly.

539.19

1836. USE OF 4p ORBITALS IN METAL—AROMATIC COMPLEXES.
D.A.Brown.
J. chem. Phys., Vol. 29, No. 5, 1086-90 (Nov., 1958).

The use of 4p orbitals of the central metal atom in metal—aromatic complexes is discussed. It is shown that, within the usual assumptions of the semiempirical molecular-orbital method, it is necessary to use Slater orbitals of a nonintegral power and with an exponent close to that calculated by the Slater rules. The electro-

neutrality principle of Pauling is also discussed and a large charge transfer within these complexes is found to contradict the original assumptions of the molecular-orbital theory.

539.19

1837. 1,2- VERSUS 1,4- ADDITION TO 1,3-BUTADIENE BY A SIMPLE LCAO—MO METHOD. F.L.Pilar.
J. chem. Phys., Vol. 29, No. 5, 1119-22 (Nov., 1958).

The addition of various reagents such as halogens and hydrogen halides to 1,3-butadiene by an ionic mechanism is ideally visualized as proceeding in two steps, namely, the electrophilic attack of the 1- or 2-position followed by nucleophilic attack to form either the 1,2- or 1,4-addition product. A simple LCAO—MO approach is applied to a proposed transition state arising from the first step of reaction. Atom stabilization energies and frontier electron densities were calculated for the various positions of attack involved during the final step of the addition. The effect of the electronegativity of the group adding during the first step relative to the electronegativity of the carbon atoms in the conjugated system is used to alter certain of the LCAO—MO parameters. Agreement of the results with experiment is discussed briefly.

539.19

1838. ENERGY LEVELS, ATOM POPULATIONS, BOND POPULATIONS IN THE LCAO MO MODEL AND IN THE FE MO MODEL. A QUANTITATIVE ANALYSIS. N.S.Ham and K.Ruedenberg.
J. chem. Phys., Vol. 29, No. 6, 1199-214 (Dec., 1958).

Quantitative results for fourteen representative organic molecules are derived and analysed on the basis of the LCAO MO model and on the basis of the FE MO model. Calculated are, besides the energy levels, the atom populations and the bond populations, quantities defined in a recent paper as an accurate measure of the distribution of electrons. The results of the LCAO MO model and of the FE MO model are then compared, and for the more important quantities considerable agreement is found. The origin of the agreement and disagreements is shown to be different from the one generally supposed. Because of their general usefulness, complete tables are given for the eigenvalues and eigenvectors of the fundamental topological matrices associated with the molecules investigated.

539.19

1839. MOBILE BOND ORDERS IN CONJUGATED SYSTEMS. N.S.Ham and K.Ruedenberg.
J. chem. Phys., Vol. 29, No. 6, 1215-29 (Dec., 1958).

A comparative study is made of the following bond orders: MO bond orders of Coulson, MO bond orders of Mulliken, MO bond populations of Platt—Ruedenberg—Scherr, VB bond orders of Pauling. The comparison is carried through on the basis of theoretical derivations and on the basis of numerical calculations for a large number of molecules. The main results are: an accurate functional connection between the Coulson and Mulliken bond orders; the characterization of a new type of bond order based on bond populations, and related linearly to bond lengths; a MO expression for VB bond orders.

539.19

1840. MOBILE BOND ORDERS IN THE RESONANCE AND MOLECULAR ORBITAL THEORIES. N.S.Ham.
J. chem. Phys., Vol. 29, No. 6, 1229-31 (Dec., 1958).

The bond orders of the resonance theory are shown to be identical with certain molecular orbital quantities which are similar to the usual MO bond orders. This equivalence, related to similar results of Dewar and Longuet-Higgins, suggests that the two theories, also in their simplified forms, are not so widely different as it is sometimes supposed.

539.19

1841. THEOREM ON THE MOBILE BOND ORDERS OF ALTERNANT CONJUGATED SYSTEMS. K.Ruedenberg.
J. chem. Phys., Vol. 29, No. 6, 1232-3 (Dec., 1958).

A generalization of Hall's theorem for Coulson bond orders in alternant molecules is derived. The new relation expresses general bond order-like quantities in terms of the topological molecular matrix. Specialization to the Mulliken bond orders furnishes an exact relation between the Coulson and the Mulliken bond order matrices in the ground state of alternants.

539.19

1842. MOLECULAR STRUCTURE AND VIBRATIONAL SPECTRA OF ALKALI HALIDE DIMERS. J.Berkowitz.
J. chem. Phys., Vol. 29, No. 6, 1386-94 (Dec., 1958).

The molecular structure and infrared-active vibrational frequencies of alkali-halide dimer molecules are calculated, assuming an ionic model similar to that used for alkali halide diatomic molecules and crystals. The results of the calculation provide further evidence for the presence of large concentrations of lithium halide dimers. The previous identification of infrared bands with monomeric alkali halides is verified and several alternatives are then suggested for the absence of dimer bands. Some inconsistencies in the dimerization energies obtained from molecular beam studies also become apparent by this treatment.

539.19 : 535.343

STRUCTURE OF THE HNO MOLECULE. See Abstr. 1280

539.19

1843. DIPOLE MOMENT OF AMMONIA-BORANE.
J.R.Weaver, S.G.Shore and R.W.Parry.
J. chem. Phys., Vol. 29, No. 1, 1-2 (July, 1958).

The dipole moment was measured as 4.9 Debye units in dioxane solution; the results are discussed briefly.

539.19 : 537.226.2

ELECTRIC DIPOLE MOMENT OF POLYPEPTIDES. See Abstr. 1411

539.19

1844. STUDIES IN NONEQUILIBRIUM RATE PROCESSES. III. THE VIBRATIONAL RELAXATION OF A SYSTEM OF ANHARMONIC OSCILLATORS.
N.W.Bazley, E.W.Montroll, R.J.Rubin and K.E.Shuler.
J. chem. Phys., Vol. 28, No. 4, 700-4 (April, 1958).

Numerical solutions of the relevant relaxation equations were obtained on the Illiac (University of Illinois electronic digital computer) for some particular cases of initial δ-function and Boltzmann distributions. The results of these calculations show that the deviations of the fractional level population from the harmonic oscillator values are very small, being of the order of the anharmonicity in the case of relaxation of the initial Boltzmann distribution, and about five times the anharmonicity for the δ-function distribution. A general analytical perturbation procedure for the solution of the relaxation equations is outlined and analytical solutions for several special cases are discussed briefly.

539.19

1845. STUDIES IN NONEQUILIBRIUM RATE PROCESSES. IV. THE ROTATIONAL AND VIBRATIONAL RELAXATION OF A SYSTEM OF ROTATING OSCILLATORS. R.Herman and K.E.Shuler.
J. chem. Phys., Vol. 29, No. 2, 366-74 (Aug., 1958).

A theoretical study is made of the rotational and vibrational relaxation of a system of rotating oscillators, represented by a rigid rotator-harmonic oscillator model, in their interaction with a constant temperature heat bath. The relevant relaxation equations for this system are derived and both numerical solutions, computed with an electronic computer, and approximate analytical solutions are obtained for the mode and rate of change of the rotational-vibrational level population with time. The results show that, owing to the large order of magnitude difference in the efficiency of translational-rotational and translational-vibrational energy transfer, there is very little coupling between the vibrational and rotational relaxation and the system of rotating oscillators relaxes essentially as if composed of two independent and noninteracting systems of harmonic oscillators and rigid rotators. A calculation of the rotational relaxation time, $t$ (relax), using the adiabatic transition probabilities given by Brout and by Takayanagi and the concomitant selection rules $\Delta J = \pm 1$ (for heteronuclear molecules) gives values for $t$(relax) which are greater by a factor of several orders of magnitude ($\sim 10^2$) than the experimental relaxation times found from shock-wave studies. This indicates clearly that rotational relaxation does not take place via a stepwise "ladder process" involving only transitions between neighbouring rotational levels.

539.19

1846. MOLECULAR COLLISIONS. I. FORMAL THEORY AND THE PAULI PRINCIPLE. G.Gioumousis and C.F.Curtiss.
J. chem. Phys., Vol. 29, No. 5, 996-1001 (Nov., 1958).

The formal theory of scattering of Gell-Mann and Goldberger is used to obtain expressions for the differential cross-sections describing collisions between two molecules with internal structure in terms of the asymptotic forms of the wave-functions. The effect of the Pauli principle is considered explicitly.

539.19

1847. ANOMALOUS DISSOCIATION OF MOLECULAR HYDROGEN BY ELECTRON IMPACT. L.A.Edelstein.
Nature (London), Vol. 182, 932 (Oct. 4, 1958).

An attempt is made to correlate the dissociation cross-section with the initial energy of the electron. Anomalies in the region of the onset potential of dissociation are thought to be due to both electronic and vibrational effects. G.I.W.Llewelyn

# SOLID-STATE PHYSICS

539.2

1848. QUANTUM THEORY OF COHESION. H.Brooks.
Nuovo Cimento Suppl., Vol. 7, No. 2, 165-244 (1958).
Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957.

539.2 : 539.58

1849. APPROXIMATE COMPRESSIBILITIES OF ELEMENTS ON THE STATISTICAL MODEL. W.G.McMillan.
Phys. Rev., Vol. 111, No. 2, 479 (July 15, 1958).
A semiempirical correction to the pressure in the Thomas—Fermi statistical model is suggested on the basis of the Dirac modification. The resulting functional relation between scaled compressibility and volume is compared with experiment.

539.2

1850. DIRECT MEASUREMENTS OF MOLECULAR ATTRACTION OF SOLIDS. B.V.Derjaguin and I.I.Abrikossova.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 1-10 (1958).
Beam balances were constructed with a photoelectromagnetic negative feedback coupling which made it possible to measure directly the resulting force of molecular attraction between plane and spherical surfaces of two plates separated by a narrow gap, as a function of the width of this gap. The width of the gap was determined from the diameter of Newton's rings. Using a simple equation, it was then possible to determine the energy of interaction per unit area of infinite plane surfaces of the same nature as a function of the width of the gap. Measurements were made for the pairs: quartz—quartz, mixed thallium halide—mixed thallium halide, and chromium—quartz, in a range of gap widths from 0.07 to 0.3 microns. In all cases, within the limits of experimental error, the results agree with the values derived from the equations of the theory of molecular attraction of macro-bodies developed by Lifshits (Dokl. Akad. Nauk SSSR, Vol. 97, 643, 1954, and Abstr. 5277/1956). At the same time, the London—Hamaker equation, which assumes the additivity of molecular interaction, is shown to be inapplicable. In the measurements, special attention was paid to the removal of surface electrical charges by means of ionization of the air, and also to the removal of dust particles and to decreasing the effect of vibrations and the viscosity of the air on the measurements. The discrepancy between the present results for quartz and those of Overbeek and Sparnaay (Abstr. 3481/1953), who obtained forces 5000 times greater than the values corresponding to the Lifshits equations, is apparently explained by the incomplete removal of surface charges in their measurements.

539.2 : 536.75

1851. RESIDUAL ENTROPY OF ICE, AND RELATED COMBINATORIAL PROBLEMS. J.L.Meijering.
Philips Res. Rep., Vol. 12, No. 4, 333-50 (Aug., 1957).
The theoretical residual entropy of disordered ice is about 5% higher than Pauling's value R ln (3/2). For the corresponding quadratic lattice the difference is 6%. Here a persistency effect is found, which in $Ag_2H_3IO_6$ must give rise to unequal a priori probabilities of the dipole orientations. The entropy computed for the graphite-type honey-comb lattice is 20% higher than that found by Lipscomb. This difference is related to a boundary effect. It is shown that Chang's expression for the entropy of diatomic molecules in a lattice can be derived directly with Pauling's method.

539.2

1852. VIBRATIONS OF A ONE-DIMENSIONAL IONIC LATTICE. H.B.Rosenstock.
Phys. Rev., Vol. 111, No. 3, 755-7 (Aug. 1, 1958).
The singularities in the distribution of vibrational frequencies in the one-dimensional ionic lattice are studied. It is shown that presence of Coulomb forces, however weak, not only produces at least one additional singularity, but also changes the nature of one singularity qualitatively.

539.2

1853. THE EFFECT OF ANHARMONICITY ON VIBRATIONS AND WAVES IN CRYSTAL (LINEAR ATOMIC CHAIN). A.I.Ansel'm and Yu.L.Rabotnikov.
Zh. tekh. Fiz., Vol. 27, No. 8, 1723-30 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1602-8 (Aug., 1957).
A method of successive approximations is used to investigate "overtone" anharmonic progressive and standing waves in atomic chains. It is shown that the momentum flux in a progressive wave vanishes, and the mechanical stress that arises is calculated. Anharmonic elongations of a bounded atomic chain are investigated.

539.2 : 539.17

NEUTRON SCATTERING ON PHONONS IN BISMUTH. See Abstr. 1781

539.2

1854. INTERACTION BETWEEN ELECTRONS AND THE LATTICE VIBRATIONS IN A NORMAL METAL. A.B.Migdal.
Zh. eksper. teor. Fiz., Vol. 34, No. 6, 1438-46 (1958). In Russian.
A method is developed which permits one to find the electron energy spectrum and dispersion of the lattice vibrations without assuming the interaction between the electrons and phonons to be small.

539.2

1855. TRANSPORT PHENOMENA IN MONOVALENT METALS. M.Tsuji.
Mem. Fac. Sci. Kyusyu Univ. B, Vol. 2, No. 4, 119-28 (Jan., 1958).
Taking into account the departure of the distribution function of lattice waves from its thermal equilibrium value, Hanna and Sondheimer (Abstr. 5493/1957) have obtained a set of interpolation formulae for the electrical and thermal conductivities and the thermoelectric powers of monovalent metals. In this paper, similar results are obtained by a more rigorous method. It is also shown that the generalized variational method of Ziman (Abstr. 397/1958) and Dorn (Z. Naturforsch, Vol. 12a, No. 9, 739-49, Sept., 1957) gives the same results.

539.2 : 538.566.2

1856. THEORY OF ELECTROMAGNETIC WAVES IN A CRYSTAL WITH EXCITONS. S.I.Pekar.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 11-22 (1958).
Light waves are considered the frequencies of which are close to or fall in a region of exciton absorption in a crystal. A relationship is obtained between polarization dipole moment of the crystal and electric field intensity; this relationship is not one of direct proportionality, as is usually assumed, but is expressed by a differential equation. For this reason the Maxwell equations are of a higher order and their solutions are more complex than the well-known ones which follow from the simple phenomenological theory. It is shown that a number of waves exists in the crystal all of which have the same frequency, polarization and direction but different refractive indices. This effect is different from double refraction and occurs also in isotropically polarizable (cubic) crystals. Existence of purely longitudinal electric waves in the crystal is proved. Surface exciton states, the analogues of surface electron states, are discussed.

539.2 : 538.566.2

ELECTROMAGNETIC WAVES IN ISOTROPIC AND CRYSTALLINE MEDIA. See Abstr. 1630

539.2 : 535.328

1857. DISPERSION OF LIGHT IN THE EXCITON ABSORPTION REGION IN CRYSTALS. S.I.Pekar.
Zh. eksper. teor.Fiz., Vol. 34, No. 5, 1176-88 (1958). In Russian.
The theory of light waves in exciton absorbing crystals developed earlier Abstr.5151/1958 and preceding abstract) on the basis of a new relation between the specific polarization and electric field is applied to cubic crystals. For each direction of propagation the existence of three types of light waves is predicted in these crystals. One of these types of waves is similar to the usual one, whereas the other two are fundamentally anomalous. The frequency dependence of the refraction indices of the three waves is considered. Fresnel's formulae are generalized for light passing through the boundary between the crystal and vacuum. New formulae are obtained for the reflection coefficient from the crystal surface and for the transparency of a plane-parallel plate. Methods for experimental verification of the theory and for obtaining a direct proof of the existence of second and third light in cubic crystals are suggested.

539.2

1858. PREDICTED RADIATION OF PLASMA OSCILLATIONS IN METAL FILMS. R.A.Ferrell.
Phys. Rev., Vol. 111, No. 5, 1214-22 (Sept. 1, 1958).
Because of their highly collective nature it is predicted that plasma oscillations in a thin metal film should, under the proper circumstances, give off ultraviolet radiation. The plasma oscillations can be excited by fast electrons, incident normal to the film and inelastically scattered by it. Surface effects are essential, and of the special types of oscillations which can occur in a plane parallel

slab of electron gas, only that involving motion normal to the slab can radiate. The yield is computed to be one photon for every one thousand electrons incident at 10 keV. The radiation is at the plasma frequency, $\omega_p$, or at 2100 A for a sodium film. Its identification should be facilitated by the characteristic $\cos\theta$ dependence of the intensity, where $\theta$ is the angle between the foil normal and the direction of emission of the photon. Straightforward computation yields a radiative mean life of $\omega_p^{-1}(\lambda_p/\pi\tau) \times (\cos\theta/\sin^2\theta)$, which is generally shorter than that due to intrinsic interband damping, except at small angles. $\lambda_p$ is the photon wavelength and $\tau$ the film thickness. From the competition of the two decay modes it should be possible to determine the intrinsic damping rate, and hence the product of the optical constants nk. The radiative lifetime is so short as to produce appreciable line-broadening, and thereby provide an independent check on the experiment. In an appendix the inelastic electron scattering coefficient is derived for the excitation in a thin film of the radiative-type plasma oscillations.

539.2

1859. THEORY OF PLASMA RESONANCE IN SOLIDS. P.A.Wolff.
Phys. Rev., Vol. 112, No. 1, 66-9 (Oct. 1, 1958).

A study is made, in a simple geometry, of the modes of a confined plasma. The modes are closely spaced in frequency and unresolvable unless the size of the plasma is comparable to the Debye length. Observation of the modes in small samples is made difficult by line broadening due to surface scattering, but might be possible in a suitably designed experiment.

539.2

1860. EVIDENCE OF CHEMICAL SHIFTS OF THE INNER ELECTRONIC LEVELS IN A METAL RELATIVE TO ITS OXIDES (Cu, $Cu_2O$, CuO). C.Nordling, E.Sokolowski and K.Siegbahn.
Ark. Fys., Vol. 13, Paper 37, 483-500 (1958).

The energies of some inner electronic levels of copper were studied in the case of the pure metal and the cuprous and cupric oxides by means of magnetic analysis of X-ray-produced photoelectrons. In all cases a shift was observed towards greater binding energy on going from the metal to the oxide, this shift being greatest (4.4 eV) for the 1s and 2s levels in the cupric oxide. The observed shift in K binding energy for CuO can be correlated to the results of entirely different investigations on the band structure of the oxide. Indications were found of changes in the natural line widths in connection with oxidation. A line in the KLL Auger spectrum from metallic copper was compared with the corresponding line from CuO. The line from the oxide was found to be somewhat lower in energy. Also, there is some evidence that the K Auger yield depends on the chemical composition of the source. A.

539.2

1861. ELECTRON STATES IN CRYSTALS. V.P.Shirokovskiĭ.
Fiz. Metallov i Metallovedenie, Vol. 6, No. 1, 3-14 (1958). In Russian.

A treatment which uses group theory and gives results not apparent from the usual band theory of electron states.

539.2

1862. INFLUENCE OF ELECTRON INTERACTIONS ON METALLIC PROPERTIES. J.G.Fletcher and D.C.Larson.
Phys. Rev., Vol. 111, No. 2, 455-62 (July 15, 1958).

The influence of electron interactions on the one-electron energy in metals is calculated. The calculation is based on the Bohm–Pines collective description of electron interactions and has for its principal approximation the treatment of the screened interaction $H_{SR}$ by perturbation theory. Results are given for the bandwidth, specific heat, relaxation time, conductivity, thermoelectric power, and diamagnetic susceptibility. Comparison with experimental values of bandwidth and specific heat for the alkali metals shows satisfactory agreement. Density-of-states plots for the alkalis are given.

539.2

1863. CORRELATION OF ELECTRON AMPLITUDES IN IMPURE METALS. P.R.Weiss and E.Abrahams.
Phys. Rev., Vol. 111, No. 3, 722-8 (Aug. 1, 1958).

The amplitude correlation function in an impure metal is the average over all possible arrangements of impurities of the correlation $\Sigma_n \psi_n^*(r')\psi_n(r)\delta(E-E_n)$, where the $\psi_n$ are eigenfunctions of a one-electron Hamiltonian including impurity potentials. The $\delta$-function restricts the sum to states n on the energy shell E. This quantity, whose usefulness in studies of impure metals is pointed out, is evaluated from first principles by means of multiple scattering techniques. If the impurity density is not too high, the amplitude correlation is $\rho(E)\ \sin[(2mE)^{1/2}R]\ \exp(-R/2\lambda)[(2mE)^{1/2}R]^{-1}$, where $\rho(E)$ is the density of states and $R = |r - r'|$.

539.2

1864. FERMI–THOMAS METHOD FOR CRYSTALS. H.Payne.
Phys. Rev., Vol. 111, No. 2, 418-22 (July 15, 1958).

A method for solving the Fermi–Thomas and Fermi–Thomas–Dirac equations for crystals is presented. The results of computing the electronic density of copper by this method are given together with those attained from the application of the spherical approximation to the Wigner–Seitz cell. Also presented are the results of cohesive energy calculations for copper, which with the inclusion of the correlation effect predict stability but only about one-third of the observed value.

539.2 : 535.345

1865. ON SOME APPLICATIONS OF THE OPW CALCULATIONS. M.Suffczyński.
Bull. Acad. Polon. Sci. Ser. Sci. math. astron. phys., Vol. 6, No. 7, 481-4 (1958).

Discusses the possibility of using the OPW (orthogonalized plane wave) method to calculate the momentum matrix element, and thence the optical absorption edge, particularly for Si and Ge.

H.Mykura

539.2

1866. GROUND-STATE ENERGY AND EFFECTIVE MASS OF THE POLARON. E.H.Lieb and K.Yamazaki.
Phys. Rev., Vol. 111, No. 3, 728-33 (Aug. 1, 1958).

The polaron Hamiltonian would be easily soluble were it not for the quartic term appearing therein. It is proposed to substitute for the quartic term a quadratic term having roughly the same properties, and in such a way that the ground-state energy of the new Hamiltonian is rigorously a lower bound for the true energy. With a very small amount of work one can obtain a lower bound as a continuous function of $\alpha$ for all values of $\alpha$. The result agrees fairly well with the results obtained by other methods. Using the equivalent Hamiltonian one can also obtain an analytic expression for the effective mass, although one cannot say it is a bound for the true effective mass. Furthermore, once one has obtained a lower bound for the energy as a continuous function of the parameters of the Hamiltonian one can rigorously derive upper and lower bounds for the ground-state expectation values of various operators. For example, it can be shown that for large $\alpha$ and large $\vec{k}$, $\langle a_k^* a_k \rangle \sim \vec{k}^{-6}$ and not $\vec{k}^{-2}\exp(-\vec{k}^2)$ as in Pekar's solution. Because of its simplicity, it is possible that this method may have application to other ground-state problems.

539.2

1867. ON THE THEORY OF THE FAST POLARON. Yu.I.Gorkun
Zh. tekh. Fiz., Vol. 27, No. 8, 1764-9 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1639-44 (Aug., 1957).

The results of a calculation of the wave-function of a fast polaron by a direct variational method are given. Dependence of the polaron energy on its translational velocity is obtained. Use is made of the Hippel criterion to find the breakdown fields for ionic dielectrics from the polaron point of view.

539.2 : 537.226.1

1868. DIELECTRIC RELAXATION OF LATTICE DEFECTS IN CRYSTALS. Y.Haven and J.H.van Santen.
Nuovo Cimento Suppl., Vol. 7, No. 2, 605-11 (1958).

Presented at the Summer School of the Italian Physical Society, Varenna, July-August 1957

539.2

1869. ON THE ENERGY OF FORMATION OF VACANCIES IN SOLID METALS. K.A.Osipov.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 5, 855-7 (1958). In Russian.

A discussion on the nature of a quantity q (the activation energy of the process by which nuclei of thermodynamic instability are formed in the metal) appearing in an equation derived by the author in his earlier work (Izv. Akad. Nauk SSSR, Otdel. tekh. Nauk, No. 7, 1957). The fact that the theoretical values of q calculated for Al, Cu, Ag, Au and Pt are in good agreement with the values of the energy of vacancy formation calculated from experimental data seems to indicate a close connection between these two values. On the other hand it is shown that $\mu a^3 = 1.5$ q ($\mu$ - shear modulus in the plane of closest atomic packing, $a^3$ - atomic volume) which indicates that q is closely connected with the shear strain energy in the crystal lattice. M.H.Slobod

539.2

1870. VACANCY PAIRS IN IONIC CRYSTALS. A.B.Lidiard.
Phys. Rev., Vol. 112, No. 1, 54-5 (Oct. 1, 1958).

Equations for the thermal equilibrium concentrations of Schottky vacancies and vacancy pairs are presented; these equations allow for the effects produced by Debye—Hückel screening.

539.2

1871. DISLOCATIONS IN THE DIAMOND LATTICE. J.Hornstra.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 129-41 (1958).

In this paper several possible structures of dislocations in the diamond lattice are discussed. Special attention is paid to the occurrence of broken bonds in the core of the dislocations and in jogs; for instance, edge-type dislocations can occur in configurations without broken bonds. Jogs can act as a source or sink of interstitials and vacancies; in the diamond lattice this is complicated by the existence of two kinds of atom sites. The most probable types of partial dislocations and the mechanism of their formation from simple dislocations are discussed. In the last section something is said about the occurrence of partial dislocations at twin boundaries and about a line imperfection with zero Burgers vector which may occur at the end of a twin lamella.

539.2

1872. THE REVELATION OF DISLOCATIONS IN METAL CRYSTALS BY EVAPORATION.
E.Votava, A.Berghezan and R.H.Gillette.
Naturwissenschaften, Vol. 44, No. 13, 372-3 (1957).

Spirals, due to screw dislocations, and ditches, due to edge dislocations, appeared on Cu crystals after heating in vacuum. Twin dislocations were invariably found to be present at incoherent twin boundaries. J.Franks

539.2

1873. DISLOCATION LOOPS IN QUENCHED ALUMINIUM.
P.B.Hirsch, J.Silcox, R.E.Smallman and K.H.Westmacott.
Phil. Mag. (Eighth Ser.), Vol. 3, 897-908 (Aug., 1958).

Electron transmission micrographs of polycrystalline aluminium quenched from ~600°C into iced brine show that the specimens contain many dislocation loops with diameters of the order of several hundred A. Some of the loops are hexagonal in shape, and occur on (111) planes, and have a Burgers vector $\frac{1}{2}$ [110] not in the plane of the loop. The loops are thought to be produced by the collapse of disks of vacancies, and the corresponding vacancy concentration is $10^{-4}$. Some of the loops disappear, while under observation in the microscope, by a mechanism of prismatic slip. In the neighbourhood of grain boundaries there is a zone depleted of loops; similar zones are observed near dislocations, whose complex configurations suggest that climb may have taken place. The observations are discussed in relation to the problems of "annealing out" of vacancies, of quench-hardening, and of the origin of the dislocation network.

539.2

1874. GENERATION OF PRISMATIC DISLOCATION LOOPS IN SILICON CRYSTALS. W.C.Dash.
Phys. Rev. Letters, Vol. 1, No. 11, 400-2 (Dec. 1, 1958).

It is assumed that helical dislocations are caused by the condensation of vacancies. Further vacancy condensation on the helix would cause it to expand and throw off a series of co-axial prismatic dislocation loops, as observed. H.Mykura

539.2 : 537.311.33

1875. EFFECT OF CRYSTAL GROWTH VARIABLES ON ELECTRICAL AND STRUCTURAL PROPERTIES OF GERMANIUM.
F.D.Rosi.
R.C.A. Rev., Vol. 19, No. 3, 349-87 (Sept., 1958).

Examination of dislocation etch-pit distribution revealed plastic deformation by octahedral slip in germanium crystals grown by the Czochralski technique. An intimate association of slip with the total number of dislocations was also found, and this suggested that deformation by slip is the main source of dislocations. Growth conditions which prevent slip by providing a planar solid—liquid interface have yielded 1-40 ohm cm crystals with dislocation density $< 10^2$ cm$^{-2}$. Significant changes in dislocation density, or carrier lifetime, or both, were obtained on varying the temperature gradient in the crystal, growth velocity, crystal orientation, and crystal size. Additions of n- and p-type impurities within their limits of solid solubility had no significant effect on dislocation density. The dependence of carrier lifetime on dislocation density in the range of 10 to $10^6$ cm$^{-2}$ was investigated in both high- and low-resistivity crystals. A maximum in carrier lifetime was obtained corresponding to a dislocation density of $3 \times 10^3$ cm$^{-2}$, and this has been attributed to the formation of copper-dislocation recombination centres. The effective cross-section for hole capture was determined in 2 ohm cm crystals for dislocations produced during crystal growth and by plastic deformation. Variations in the number of dislocations produced during crystal growth had significant effects on (1) the precipitation of copper from a supersaturated solid solution, (2) the surface recombination velocity, and (3) the wettability of molten indium on {111} surfaces.

539.2

1876. X-RAY-INDUCED COLOR CENTERS IN MgO.
R.W.Soshea, A.J.Dekker and J.P.Sturtz.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 23-33 (1958).

An analysis is presented of the optical absorption spectrum induced in MgO crystals by heat treatment in oxygen; the analysis gives Gaussian bands near quantum energies of 5.7, 4.8 and 4.3 eV for the region investigated, which extends to 6 eV. A similar analysis of the absorption spectrum induced by X-irradiation at room temperature gives Gaussian bands near 5.7, 4.8, 4.3 and 2.3 eV, plus absorption in the region below 4 eV. Results concerning the growth and thermal decay of the optical absorption induced by X-irradiation at room temperature and at 600°C are presented. A study has also been made of the spectrum induced by X-irradiation of crystals previously coloured by heat treatment in oxygen. The results are discussed in terms of a model which assumes the presence of ions of variable valence.

539.2 : 535.345

1877. OPTICAL ABSORPTION BY F CENTERS IN ALKALI HALIDES. W.T.Doyle.
Phys. Rev., Vol. 111, No. 4, 1072-7 (Aug. 15, 1958).

The integrated optical absorption due to F centres in KCl, KBr, and NaCl was measured using a modification of Kleinschrod's method which eliminates salt-effect errors. Assuming the validity of the f sum rule, the results are used to obtain experimental values for the local field correction. The Onsager local field gives better agreement with experiment than does the classical expression of Lorentz. To facilitate comparison with other work the results were also used to compute oscillator strengths using Smakula's equation. The f values are 0.91 ± 0.12, 0.85 ± 0.08, and 0.86 ± 0.05 for KCl, KBr, and NaCl, respectively.

539.2

1878. V-TYPE CENTER RESONANCE OF NEUTRON-IRRADIATED LiF AT ROOM TEMPERATURE.
Y.W.Kim, R.Kaplan and P.J.Bray.
Phys. Rev., Vol. 111, No. 6, 1468-9 (Sept. 15, 1958).

A V-type centre similar to one described by Känzig and coworkers was found in LiF single crystals neutron-irradiated at room temperature. Analysis of the s and p admixture in the electron wavefunction, using the Hamiltonian of Woodruff and Känzig, is made from the angular dependence of the electron-spin resonance spectrum.

539.2 : 535.345

EXPERIMENTAL AND THEORETICAL STUDY OF THE SHAPE OF THE F ABSORPTION IN KCl. See Abstr. 1297

539.2 : 535.345

THEORY OF THE BETA BAND IN ALKALI HALIDE CRYSTALS. See Abstr. 1300

539.2 : 539.14

1879. NUCLEAR MAGNETIC RESONANCE IN LiF.
F.J.Low and C.F.Squire.
J. Phys. Chem. Solids, Vol. 5, No. 1-2, 85-8 (1958).

The line-width of the nuclear magnetic resonance in a single crystal of LiF was observed as 11 G for $Li^7$ and 12 G for $F^{19}$; these values are at constant temperatures between 1.4 and 80° K. The spin—lattice relaxation time, $T_1$, was measured by observing the exponential growth of the absorption signal after saturation. The value of $T_1$ for $Li^7$ is $3.6 \times 10^4$ sec at 1.4° K and is $7.8 \times 10^2$ sec at 80° K; for $F^{19}$ the value of $T_1$ is $1.8 \times 10^4$ sec at 1.4° K and is $3.0 \times 10^2$ sec at 80° K. These values are for a steady field of 4 kG.

539.2

1880. NUCLEAR MAGNETIC RESONANCE IN SOLID CYCLOPENTENE. I.J.Lawrenson and F.A.Rushworth.
Proc. Phys. Soc., Vol. 72, Pt 5, 791-6 (Nov., 1958).

The variation of the nuclear magnetic resonance absorption line of cyclopentene was measured from 20° K to the melting point at 138° K. Below the specific heat transition temperature of 87° K the lattice is effectively rigid and there is no evidence corresponding to a reported specific heat anomaly at 54° K. Above 87° K the second moment of the absorption line is reduced and this is interpreted in terms of molecular motion about an axis perpendicular to the plane

of the four co-planar carbon atoms of the molecule. Above 124°K a further reduction in the second moment is thought to be due to self-diffusion of the molecules through the crystal lattice. Information is also obtained which confirms the nonplanar structure of the cyclopentene molecule.

539.2

1881. COPPER NUCLEAR MAGNETIC RESONANCE IN Cu–Ni AND Cu–Mn ALLOYS. A.C.Chapman and E.F.W.Seymour.
Proc. Phys. Soc., Vol. 72, Pt 5, 797-809 (Nov., 1958).

The $Cu^{63}$ resonance was observed in copper–nickel alloys containing up to 9.2% Ni, at 3 Mc/s and 7 Mc/s in the temperature range 20°K to 290°K. The resonance shows a reduction in intensity and a shift to lower frequencies which are larger at the lower frequency and substantially independent of temperature. The line width is not much greater than in pure copper. These effects are interpreted as due to an interaction between the electric quadrupole moment of the $Cu^{63}$ nucleus and electric field gradients resulting from the difference in size between copper and nickel ions. Any magnetic effect of nickel ions is negligible. The resonance in copper-manganese alloys containing up to 6.1% Mn at the same frequencies and temperatures has a width proportional to the applied field and inversely proportional to the absolute temperature. The direct magnetic interaction with manganese ions is insufficient to account for the broadening. If the results are interpreted in terms of an indirect interaction through the conduction electrons, of the form proposed by Behringer (J. Phys. Chem. Solids, Vol. 2, 209, 1957) and Yosida (Abstr. 7220/1957, 607/1958), an s–d exchange constant six times the Mn free atom value must be assumed. A large decrease in width on heat treatment is tentatively attributed to clustering of Mn ions.

539.2

1882. ELECTRON-NUCLEAR DOUBLE RESONANCE OF F CENTERS IN LITHIUM FLUORIDE. N.W.Lord.
Phys. Rev. Letters, Vol. 1, No. 5, 170-1 (Sept. 1, 1958).

Double resonance spectra were obtained with an LiF crystal with a high concentration of F-centres under simultaneous excitation by a microwave and a radiofrequency field. Hyperfine interaction energies are given for the first three shells of nuclei surrounding the F-centre. J.Franks

539.2

1883. PARAMAGNETIC RESONANCE IN RARE EARTH TRICHLORIDES. C.A.Hutchison, Jr and E.Wong.
J. chem. Phys., Vol. 29, No. 4, 754-60 (Oct., 1958).

Paramagnetic resonance absorption of all the naturally occurring rare earth trivalent ions in the LaCl structure was investigated. The results are summarized in the form of a tabulation of the parameters $g_{\parallel}$, $g_{\perp}$, A, B, P, Δ in the spin-Hamiltonian. Theoretical calculations of crystal field states and eigenvalues as well as of $g_{\parallel}$ and $g_{\perp}$, based on optical measurements, are discussed.

539.2 : 537.311.62

1884. ANOMALOUS SKIN EFFECT IN A MAGNETIC FIELD. D.C.Mattis and G.Dresselhaus.
Phys. Rev., Vol. 111, No. 2, 403-11 (July 15, 1958).

A classical and quantum mechanical derivation of cyclotron resonance in metals is given. The classical result differs slightly from that obtained by Azbel and Kaner. The quantum derivation yields the same result as the classical calculation except that in the limit of low quantum numbers or high magnetic fields a de Haas–van-Alphen type of variation of the surface impedance occurs rather than the resonance behaviour.

539.2 : 621.318.12

1885. AN INVESTIGATION INTO THE MAGNESIUM AND MAGNESIUM–MANGANESE FERRITE SYSTEMS. L.C.F.Blackman.
J. Electronics and Control, Vol. 5, No. 4, 373-84 (Oct., 1958).

The influence of both manganese and firing conditions on certain physical and chemical properties of iron-deficient magnesium ferrite was investigated. The results suggest that $Fe^{2+}$ and $Mn^{3+}$ can coexist, at least to a certain extent, in the solid state. It is also shown that the excess of magnesia, which is added to improve the microwave performance of the material, plays an important role in the chemistry of the ferrite phase.

# STRUCTURE OF SOLIDS

539.215.08

1886. NOMOGRAPHS FOR PARTICLE SIZE ANALYSIS BY SEDIMENTATION AND PERMEABILITY METHODS.
G.D.Joglekar and B.R.Marathe.
J. sci. industr. Res., Vol. 17B, No. 6, 232-5 (June, 1958).

Describes two nomographs constructed for particle size analysis by the sedimentation method based on Stokes' law, and by the air permeability method employing the apparatus developed by Lea and Nurse (Journal of the Society of Chemical Industry, London, Vol. 58, 277, 1939).

539.216

1887. THE PHYSICS OF FIBRES WITH SPECIAL REFERENCE TO WOOL. A.B.D.Cassie.
Brit. J. appl. Phys., Vol. 9, No. 9, 341-8 (Sept., 1958).

Review, with particular reference to physical problems (mainly in relation to fibre assemblies such as fabrics) which arise purely from the geometrical form of the fibres and their ability to exchange water vapour with the atmosphere.

539.217

1888. ON THE DIFFUSION OF ANTIMONY INTO SILVER. W.Weller.
Ann. Phys. (Leipzig), Vol. 20, No. 1-6, 42-4 (1957). In German.

Heated layers of evaporated layers of Ag with Sb on top were examined by electron diffraction and evidence for the intermediate phase Ag–Sb (Sb approximately 27%) was obtained.

C.A.Hogarth

539.217

1889. A TECHNIQUE FOR THE MEASUREMENT OF DIFFUSION COEFFICIENTS IN MOLTEN SALTS.
C.A.Angell and J.O'M.Bockris.
J. sci. Instrum., Vol. 35, No. 12, 458-61 (Dec., 1958).

A diffusion method is described in which two columns of molten salt to be interdiffused, initially separately by a gas bubble at reduced pressure, are joined by breaking a capillary and allowing external pressure to eliminate the bubble. After a period of diffusion, the salt distribution is preserved by causing the glass diffusion tube to break at the point of initial junction while the tube is still in position in the high temperature zone of the furnace. The method was tested with a 1 : 1 $CdCl_2$–KCl mixture. The self-diffusion coefficient of cadmium is found to be 1.40 $cm^2\ sec^{-1}$ at 470°C, with a probable error of 2.5%. The method is applicable up to temperatures of the order of 1000°C.

539.217

1890. INTERSTITIAL DIFFUSION OF COPPER IN PbS SINGLE CRYSTALS. J.Bloem and F.A.Kröger.
Philips Res. Rep., Vol. 12, No. 4, 281-302 (Aug., 1957).

At temperatures $100° < T < 500°C$, Cu can diffuse rapidly into PbS via interstitial sites. Existing cation vacancies are filled by copper, while copper may also be bound by sulphur at internal surfaces (cracks, dislocations). The diffusion coefficient follows the relation

$$D_{Cu} = 5 \times 10^{-3} \exp(-7130/RT)\ cm^2/sec.$$

Interstitial copper gives rise to donor levels lying ≅ 0.02 eV below the conduction band, and thus causes n-type conductivity. In the presence of sulphur in the atmosphere ($H_2S$), copper does not enter the crystal; interstitial copper already present in the crystal may be drawn out when the crystal is heated in such an atmosphere. The effect is attributed to a lowering of the thermodynamic potential of copper by the formation of $Cu_2S$ or CuS.

539.217

1891. INTERSTITIAL DIFFUSION OF NICKEL IN PbS SINGLE CRYSTALS. J.Bloem and F.A.Kröger.
Philips Res. Rep., Vol. 12, No. 4, 303-8 (Aug., 1957).

Under reducing conditions, nickel may penetrate into PbS crystals at temperatures $T < 500°C$, at which the self-diffusion in PbS is negligible; it diminishes p-type conductivity and may cause n-type conductivity with donors of a depth E ≅ 0.03 eV. The diffusion probably takes place via the interlattice with a diffusion constant

$$D_{Ni} = 17.8 \exp(-22000/RT)\ cm^2\ sec^{-1}.$$

Under sulphurizing conditions ($H_2S$) the nickel can be drawn out of the crystal again and the original conductivity restored.

539.217

1892. DIFFUSION ALONG DISLOCATIONS.
G.P.Williams, Jr and L.Slifkin.
Phys. Rev. Letters, Vol. 1, No. 7, 243-4 (Oct. 1, 1958).

In order to test the postulate that even with a normal diffusion profile, values of D larger than the normal might be observed due to help in the diffusion process arising from dislocations, thin layers of $Au^{198}$ were deposited on the ends of cylindrical single crystals of Ag and diffusion measurements were made, taking extreme precautions and using very short diffusion times. A diffusion tail was observed at larger distances from the source, believed to be due to assisted diffusion along dislocations. C.A.Hogarth

539.217

1893. BLUNTING OF TUNGSTEN NEEDLES BY SURFACE DIFFUSION. J.L.Boling and W.W.Dolan.
J. appl. Phys., Vol. 29, No. 3, 556-9 (March, 1958).

Progressive blunting of tungsten needles heated in vacuum is made continuously or intermittently visible by a technique permitting needles to be heated while mounted in a conventional electron microscope. This technique permits the study of surfaces having small radii of curvature where detectable geometric changes due to diffusion occur in conveniently short periods of time. When the needle shape remains similar to its original geometry as its radius increases, a theory of Herring is applicable for distinguishing whether the transport process involved is volume or surface diffusion. Evidence is presented which indicates that surface diffusion predominates in the conditions of these experiments, i.e. for temperatures from 2600° K to 2900° K and radii from $3 \times 10^{-6}$ cm to $3 \times 10^{-5}$ cm.

539.217.3

1894. A NEW APPROACH TO THE INVESTIGATION OF THE CAUSE OF MOISTURE EXPANSION OF CERAMIC BODIES.
T.Demediuk and W.F.Cole.
Nature (London), Vol. 182, 1223-4 (Nov. 1, 1958).

The moisture expansion of pure co-precipitated and mixed gels of silica and alumina, some with an addition of an impurity of sodium oxide, was studied experimentally. Results are shown graphically for autoclaved test pieces of co-precipitated gels in saturated steam at 200°C which were fired at temperatures ranging from 850° to 1200° C, and for pure and impure (addition of 2% sodium oxide) gels with silica/alumina ratios of 2, formed by co-precipitation and by mixing wet precipitated gels of the two components. The results which are discussed demonstrate that amorphous alumino-silicates, amorphous silica and $\gamma$-alumina have an important influence, dependent on the composition of the bodies and the firing temperatures, on the moisture expansion of ceramic bodies. S.Weintroub

539.219 : 537.226.2

1895. STRUCTURAL TRANSITIONS IN BARIUM TITANATE–ZIRCONATE TRANSDUCER MATERIALS.
R.C.Kell and N.J.Hellicar.
Acustica, Vol. 6, No. 2, 235-8 (1956).

The properties of ceramic materials of the barium titanate–zirconate system having compositions with Ti : Zr ratios between 100 : 0 and 70 : 30 are described. Curves of permittivity and resonant frequency against temperature give a more sensitive indication of transition temperatures than X-ray powder photographs, as well as being more easily and rapidly obtained. The most suitable transducer material within this system is that having a Ti : Zr ratio of 95 : 5. This material has an orthorhombic phase which is stable between 5° and 50° C and the change in resonant frequency over this temperature range is only 4%.

539.219 : 538.22

1896. THE NON-MARTENSITIC DIFFUSIONLESS TRANSITION IN MANGANESE ARSENIDE AT ABOUT 40° C.
Z.S.Basinski and W.B.Pearson.
Canad. J. Phys., Vol. 36, No. 8, 1017-21 (Aug., 1958).

The transition is accompanied by a loss of ferromagnetism of MnAs on proceeding to higher temperature. It was found that the transformation takes place by a novel diffusionless non-martensitic mechanism. It appears that plastic deformation of MnAs is impossible and so, instead of the change following the martensitic pattern, the strain energy of the transformation is minimized by a fragmentation of the crystal grains into pencil-like subgrains whose direction lies parallel to the c-axis of the crystals.

539.219

1897. NONSTOICHIOMETRY IN URANIUM DIOXIDE.
S.Aronson and J.Belle.
J. chem. Phys., Vol. 29, No. 1, 151-8 (July, 1958).

A thermodynamic study of the uranium–oxygen system, primarily in the single phase region $UO_2$–$UO_{2.20}$, was made at temperatures of 1150° to 1350° K. An electrochemical technique was used to obtain e.m.f. measurements on uranium oxide half-cells. The cells were of the type Fe, FeO|$(ZrO_2 + CaO)$|$UO_{2+x}$, Pt where x varied from 0.01 to 0.20. Partial molar free energies, entropies and enthalpies of solution of oxygen in $UO_{2+x}$ are calculated. The partial molar free energy is a linear function of temperature at constant composition. The partial molar entropy increases negatively with increasing oxygen content. Equations relating the thermodynamic quantities to the degree of nonstoichiometry are developed on the assumption that the $UO_{2+x}$ region can be treated as an interstitial solution of oxygen ions in the $UO_2$ fluorite lattice. Semiquantitative agreement with the data is obtained.

539.219 : 536.631

1898. DILUTION EFFECTS IN REGULAR ASSEMBLIES.
G.M.Bell.
Proc. Phys. Soc., Vol. 72, Pt 4, 649-60 (Oct., 1958).

A study is made of the thermal behaviour of solid mixtures, containing a component A with molecules having several orientation states whose cooperative interaction leads, in pure A, to a second-order transition with a discontinuity in the specific heat and a diluting component B with molecules of the same size. Regular models are used and it can be shown from previous work on ternary assemblies that if A has two equivalent orientation states and complete equilibrium is attained, then the curve of critical temperature against the mole fraction $x_A$ of A passes through the origin. It is shown here that if A–B diffusion is forbidden in the temperature range concerned so that the distribution of A and B is fixed, though A molecules can change their orientation, then the specific heat is continuous below a critical value of $x_A$. This effect depends on short-range ordering and a first-order quasi-chemical approximation is used. Similar results are obtained when A has three available orientation states. A short investigation is also made of results when the interaction with B removes the equivalence between the two states of A. The effects here do not depend on short-range ordering, a random statistical approximation is used and it is found that even the smallest proportion of B renders the specific heat continuous with a maximum replacing the discontinuity. Finally, these various types of behaviour are briefly compared with some observed dilution effects.

539.23 : 538.221

YOUNG'S MODULUS AND MAGNETIC SUSCEPTIBILITY.
See Abstr. 1588

539.231 : 537.534.8

SPUTTERING OF SILVER BY H AND He IONS AND ATOMS.
See Abstr. 1541-2

539.27

1899. A METHOD OF OBTAINING IMAGES IN ELECTRON DIFFRACTION AND MICROSCOPY WITHOUT A PHOTOGRAPHIC EMULSION. J.Trillat and L.Tertian.
C.R. Acad. Sci. (Paris), Vol. 247, No. 5, 582-4 (Aug. 4, 1958).
In French.

The photographic plate is replaced by an insulating layer. The distribution of electron charge is made visible by applying a fine powder charged positively. A.E.I. Research Laboratory

539.27

1900. TEMPERATURE AND SPECIMEN VARIATIONS IN THE ELECTRON MICROSCOPE. K.J.Hanssen.
Z. Naturforsch., Vol. 11a, No. 10, 878-80 (1956). In German.

Chemical reactions and structural changes within the specimen in the electron microscope can be caused by the direct ionizing action of the incident electrons. These interactions are described and a comparison is made with the specimen variations caused, for example, by thermal heating in a vacuum furnace.
A.E.I. Research Laboratory

# ELASTICITY . STRENGTH . RHEOLOGY

539.32

1901. ELASTIC CONSTANTS OF SILVER AND GOLD.
J.R.Neighbours and G.A.Alers.
Phys. Rev., Vol. 111, No. 3, 707-12 (Aug. 1, 1958).

The three constants $C_{44}$, $\frac{1}{2}(C_{11}-C_{12})$, and $\frac{1}{2}(C_{11}+C_{12}+2C_{44})$ were directly measured for silver and gold in the temperature range between 4.2 and 300°K. The various contributions to the values of the 0°K constants are analysed in terms of a simple model which quite successfully describes copper. It is concluded that such a model is unsatisfactory when applied to the heavier noble metals because these appear to have large noncentral forces contributing to their constants. Combined with pressure data the present results show the elastic constants to be explicit functions of temperature. The Debye characteristic temperatures calculated from the 0°K elastic constants are shown to be in substantial agreement with the results from calorimetry.

539.32

1902. PRESSURE DERIVATIVES OF THE ELASTIC CONSTANTS OF COPPER, SILVER, AND GOLD TO 10 000 BARS.
W.B.Daniels and C.S.Smith.
Phys. Rev., Vol. 111, No. 3, 713-21 (Aug. 1, 1958).

The pressure derivatives of the elastic constants of the homologous series of metals copper, silver, and gold were measured over the pressure range from 0 to 10 000 bars, using a modified ultrasonic pulse-echo method. Means were devised to measure the change of elastic constant with pressure as directly as possible. The values found for the pressure derivatives of the elastic constants are as follows:

| | Cu | Ag | Au |
|---|---|---|---|
| $dB_S/dP$ | 5.59 | 6.18 | 6.43 |
| $dC/dP$ | 2.35 | 2.31 | 1.79 |
| $dC'/dP$ | 0.580 | 0.639 | 0.438 |

The notation $C = C_{44}$, $C' = (C_{11} - C_{12})/2$, and $B_S = (C_{11} + C_{12})_S/3$ is used. The data for each metal, of the three elastic constants and their pressure derivatives, are interpreted in terms of conventional theory. The theoretical contributions of long-range interactions are subtracted off and the remainder attributed to short-range nearest-neighbour interaction. The analysis indicates that these must be non-central, many-body interactions in order to account for the shear constants and especially their pressure derivatives. The many-body character of the interactions is of rapidly increasing importance in the sequence copper, silver and gold.

539.32

1903. ELASTIC CONSTANTS OF ZINC FROM 4.2°K TO 77.6°K.
C.W.Garland and R.Dalven.
Phys. Rev., Vol. 111, No. 5, 1232-4 (Sept. 1, 1958).

The adiabatic elastic constants of zinc single crystals were measured by an ultrasonic pulse technique. The values extrapolated to 0°K are: $c_{11} = 1.770$, $c_{33} = 0.685$, $c_{44} = 0.459$, $c_{12} = 0.348$, $c_{13} = 0.528$ in units of $10^{12}$ dynes/cm$^2$. A Debye characteristic temperature, $\theta$, of $327° \pm 5°$K is calculated at 0°K by averaging the inverse cube of the longitudinal and transverse elastic wave velocities over all directions of propagation.

539.32

1904. ELASTIC CONSTANTS OF CALCIUM FLUORIDE.
R.Srinivasan.
Proc. Phys. Soc., Vol. 72, Pt 4, 566-75 (Oct., 1958).

Employing Born's theory of crystal lattices, the elastic constants of fluorspar were evaluated theoretically. Besides the Coulomb forces, repulsive forces between nearest neighbour calcium and fluorine atoms and fluorine–fluorine atoms were assumed and the constants of the repulsive energy were evaluated from the equilibrium condition, the experimentally determined compressibility and the principal Raman frequency of fluorspar. The experimental values of $c_{11}$, $c_{12}$ and $c_{44}$ are in fair agreement with the theoretically calculated values. Born's theory gives the sign of $c_{12}-c_{44}$ for fluorspar correctly but the theoretically calculated value of $c_{12}-c_{44}$ is only about half the experimentally observed value.

539.371

1905. OBSERVATIONS CONCERNING DELAYED ELASTIC EFFECTS IN GLASS. W.C.Levengood and T.S.Vong.
J. Opt. Soc. Amer., Vol. 49, No. 1, 61-6 (Jan., 1959).

Indentation regions were formed in glass by pressing a hardened steel ball into the surface using loads below the fracture limit. These indented regions were found to recover with time and the process was studied with optical interference methods. A linear relationship was found between the logarithm of the depth of the indentation and the logarithm of the elapsed time after the load removal. The maximum load studied was about $5 \times 10^5$ lb/in$^2$. The indentation effect could still be observed at loads around $1 \times 10^5$ lb/in$^2$.

539.374

1906. SOME OBSERVATIONS ON THE DEPENDENCE OF STRAIN ON STRESS FOR ICE. L.W.Gold.
Canad. J. Phys., Vol. 36, No. 10, 1265-75 (Oct., 1958).

Observations were made on the longitudinal and transverse strain of rectangular ice samples stressed at the rate of 2 kg cm$^{-2}$ sec$^{-1}$ to a maximum stress of 10 kg cm$^{-2}$. The duration of the stress was kept less than 10 sec. Under these conditions the ice behaved elastically. The observations indicated that two deformation processes contributed to the measured strain. It is concluded that the two sources of strain are deformation of the grains and slip at the grain boundaries.

539.4

1907. MECHANICAL TESTING OF MATERIALS IN THE TRANSITION REGION BETWEEN STEADY FLOW AND FAILURE.
A.Jobling, E.Oppenheimer and J.E.Roberts.
Brit. J. appl. Phys., Vol. 9, No. 6, 235-40 (June, 1958).

An attempt was made to overcome some of the defects of the standard methods of mechanical testing of materials. The new method, in which the deformation is brought about by attaching the specimen to a substrate, shows that when the final mechanical failure occurs, continuity is preceded by a region of disturbed flow in which the flow lines appear as a pattern of remarkable regularity, the direction of which is not that of maximum shear. Materials such as dry powders, pastes, polymers and vacuum-deposited metals were studied and show unexpected common features, e.g. fatigue and relaxation or work hardening by vibrations.

539.4.011.25

1908. THE STATIC AND DYNAMIC STRENGTH OF A CARBON STEEL AT LOW TEMPERATURES. C.J.Maiden and J.D.Campbell.
Phil. Mag. (Eighth Ser.), Vol. 3, 872-85 (Aug., 1958).

Previous investigations of the effect of temperature on the static and dynamic strength of steel are briefly reviewed. A description is given of tests in which small specimens of a medium-carbon steel were compressed at high rates of strain and at temperatures ranging from 15°C to – 121°C. Dynamic stress–strain curves obtained from these tests are compared with stress–strain curves obtained from tests at normal rates of strain, at temperatures from 15°C to –183°C. The results indicate that the effect on the stress–strain curve of increasing the average strain rate to 600 sec$^{-1}$ is comparable to that of lowering the test temperature to –183°C, the upper yield stress being multiplied some $2\frac{1}{2}$ times and the lower yield strain being increased considerably. The effect of testing at high rates and low temperatures is to raise the curve still further. Metallographic examination shows that the slip occurring in the ferrite at low temperatures and normal rates is finer than that obtained at room temperature; also there is less multiple slip. These characteristics were also observed at high strain rates. No twinning took place in the static tests, even at the lowest temperature. In the dynamic tests, twins were not formed at room temperature, but were formed at the lower test temperatures.

539.4.016.2 : 539.26

1909. X-RAY STUDY OF COLD WORK IN MOLYBDENUM.
J.Despujols and B.E.Warren.
J. appl. Phys., Vol. 29, No. 2, 195-7 (Feb., 1958).

Filings from a molybdenum rod, pressed into a briquet, were used as the cold-worked sample. Satisfactory peak shapes for 110, 200, 211, 220, and 310 were obtained with filtered CuK$\alpha$. Peak shapes for 400 and 422 obtained with filtered MoK$\alpha$ were not satisfactory, partly because of fluorescence radiation. Peaks were recorded with a Norelco diffractometer, and instrumental broadening corrected by the Stokes method. The Fourier coefficients indicate

approximately isotropic incoherent domains L = 260 A, and strains inversely as Young's modulus. Molybdenum is similar to tungsten in that there is no evidence for faulting on (211) as a result of cold work.

539.42

1910. TENSILE STRENGTH OF PLASTICS: EFFECTS OF FLAWS AND CHAIN RELAXATION. F.Bueche.
J. appl. Phys., Vol. 29, No. 8, 1231-4 (Aug., 1958).

A theory for the tensile strength of amorphous plastics is presented. It extends a previous theory so as to include the effects of imperfections and chain relaxations. The result obtained shows that the time taken for a plastic to break $t_c$ under constant stress F is given by

$$F = -B \ln(t_c) + C,$$

where B and C are molecular constants. The experimental values found for these constants are shown to be consistent with their molecular interpretation. This extended theory shows that the effect of chain relaxations is the major time dependent factor as far as strength is concerned.

539.431 : 537.226.2

MECHANICAL LOSSES OF LOW-PRESSURE POLYETHYLENE. See Abstr. 1416

539.434

1911. ACTIVATION ENERGY FOR CREEP OF TIN.
L.G.Bonar and G.B.Craig.
Canad. J. Phys., Vol. 36, No. 11, 1445-9 (Nov., 1958).

The literature reports values ranging from 8000 to 26 000 cal per g-atom for the activation energy for the creep of tin. The present investigation analysed the results of constant stress creep tests during steady state creep, and by means of temperature cycling. A value of approximately 9000 cal per g-atom for the creep of high purity tin in the temperature range 300 to 350°K was obtained.

539.6

1912. MEASUREMENTS OF ATTRACTIVE FORCES BETWEEN FLAT PLATES. M.J.Sparnaay.
Physica, Vol. 24, No. 9, 751-64 (Sept., 1958).

Results of experiments concerning attractive forces between flat metal plates, and a description of the apparatus used, are given. The observed attractions do not contradict Casimir's theoretical prediction. An explanation of results of earlier measurements made by the author on the attraction between clean, and also between silvered glass and quartz plates, all brought together in an ionized atmosphere, is suggested. These results were due to differences in the surface potentials of the opposing plates.

539.61

1913. ELECTRONIC ADHESION THEORY OF METALS JOINED BY A SEMICONDUCTOR INTERLAYER.
B.V.Deryagin and V.P.Smilga.
Dokl. Akad. Nauk SSSR, Vol. 121, No. 5, 877-80 (1958). In Russian.

The authors refer to the qualitative research done by Deryagin and Krotova in 1948 (Dokl. Akad. Nauk SSSR, Vol. 61, No. 5, 1948; see also "Adgeziya" (Adhesion), published in 1949 by the Academy of Sciences of the USSR), and derive an exact mathematical solution of the problem, by using its mathematical identity with the problem of the electrostatic interaction of two surfaces with unequal charges, separated by an electrolyte layer. This interaction had been dealt with in the theory of the heterocoagulation of colloidal systems. One of the theoretically obtained conclusions is that, when the thickness of the semiconductor film between two different metallic surfaces is sufficiently reduced, it is always possible to attain an increase of the density of the double layer and consequently of the force of adhesion. F.Lachman

539.89 : 535.345 : 539.1.07

1914. EFFECTS OF PRESSURE ON SOME OPTICAL AND ELECTRICAL PROPERTIES OF DIAMONDS.
F.C.Champion and J.R.Prior.
Nature (London), Vol. 182, 1079-80 (Oct. 18, 1958).

Neither the $\beta$-ray bombardment current nor the ultraviolet absorption cut-off wavelength of conduction-counter crystals was found to change under pressures of up to $10^4$ atmospheres. E.A.Mussett

539.893

1915. HIGH-PRESSURE TECHNIQUES.
D.M.Warschauer and W.Paul.
Rev. sci. Instrum., Vol. 29, No. 8, 675-9 (Aug., 1958).

Information on hydrostatic pressure techniques up to 20 000 kg/cm$^2$. General pressure techniques described are: low temperature seals, experience with small diameter tubing, a pressure measuring bridge, and various tubing seals. Optical techniques considered are: optical windows of sapphire, germanium, and silicon; suitable pressure fluids; and a mechanism for moving samples inside a pressure vessel for use to 10 000 kg/cm$^2$.

539.893 : 531.787

1916. MANOSTAT FOR HIGH-PRESSURE OPERATIONS.
H.H.Reamer and B.H.Sage.
Rev. sci. Instrum., Vol. 29, No. 8, 709-12 (Aug., 1958).

The manostat will maintain isobaric conditions with a precision of about 1 part in 100 000 at pressures from 500 to 10 000 lb/in$^2$. The equipment functions satisfactorily as a pressure transducer for control purposes.

# PHYSICAL CHEMISTRY

## PHASE EQUILIBRIUM CHEMICAL REACTIONS

541.124 : 536.7

1917. ON THE LE CHATELIER—BRAUN PRINCIPLE. I.Fényes.
Acta phys. Hungar., Vol. 8, No. 4, 419-23 (1958). In German.

The conditions for thermodynamic stability impose certain inequalities on the thermodynamic coefficients of a "chemical" system of interacting phases. These conditions (the "Le Chatelier—Braun principle") are here given an alternative expression, generalized and briefly discussed. R.O.Davies

541.126

1918. KINETICS OF DECOMPOSITION OF ISOBUTYRYL PEROXIDE AND REACTIONS OF ISOPROPYL RADICALS.
J.Smid and M.Szwarc.
J. chem. Phys., Vol. 29, No. 2, 432-7 (Aug., 1958).

The kinetics of decomposition of isobutyryl peroxide was investigated in isooctane solution. The decomposition was shown to be unimolecular, the activation energy being 27.3 kcal/mole and the frequency factor $2.8 \times 10^{14}$ sec$^{-1}$. The lower activation energy of this decomposition, as compared with decompositions of other acyl peroxides, suggests that energy is supplied to the O—O bond by the decarboxylation of radicals resulting from the dissociation of this peroxide. The reactions of isopropyl radicals formed in the dissociation process was studied quantitatively.

541.126

1919. PSEUDO-ENERGY TRANSFER IN SOME UNIMOLECULAR DECOMPOSITIONS. M.Szwarc and L.Herk.
J. chem. Phys., Vol. 29, No. 2, 438-40 (Aug., 1958).

The unimolecular decomposition of molecules involving rupture of a bond and formation of unstable radicals (i.e. ones which decompose exothermally) is discussed. It is shown, by using contour maps that two cases should be considered. If the decomposition of the unstable radical does not involve activation energy, then the process starts as expansion of one bond, but eventually the reaction path turns toward the centre and the process proceeds as a simultaneous decomposition of the molecule into three or more fragments. The transition point is represented by a saddle point and the activation energy is lower than the expected bond dissociation energy. The exothermicity of the radical decomposition helps in the primary dissociation process. On the other hand, if the decomposition of the unstable radical does involve activation energy, then the unimolecular rupture of the first bond proceeds normally.

541.126

1920. REACTION OF METHYL RADICALS WITH ETHYLENE.
R.K.Brinton.
J. chem. Phys., Vol. 29, No. 4, 781-6 (Oct., 1958).

The gas phase reaction between methyl radicals and ethylene

was studied between 124° and 159° by the thermal decomposition of di-t-butyl peroxide in presence of ethylene. The value of $k_{4a}/k_3^{1/2}$ for the reactions,

$$CH_3 + C_2H_4 \xrightarrow{k_{4a}} C_3H_7 \qquad 2CH_3 \xrightarrow{k_3} C_2H_6,$$

is $3.3 \times 10^{-7}$ exp(-8660/RT) molecule$^{-1/2}$ cm$^{3/2}$ sec$^{-1/2}$ and the steric factor for the addition of methyl radicals to ethylene is about $7.6 \times 10^{-3}$. At low ethylene concentrations no evidence could be found for polymerization beyond the initial methyl radical addition.

541.127

1921. REACTION OF OXYGEN ATOMS WITH NITRIC OXIDE.
P.Harteck, R.R.Reeves and G.Mannella.
J.chem. Phys., Vol. 29, No. 6, 1333-5 (Dec., 1958).

The rate of reaction of oxygen atoms with nitric oxide was studied at several pressures (0.62, 0.85, 1.11 mm Hg) by measuring the relative intensities of the oxygen afterglow. The consumption of O atoms was observed as a three-body recombination ($NO + O + M \rightarrow NO_2 + M$). At room temperature the reaction coefficient was found to be $k_2 = 7.6 \times 10^{-32}$ cm$^6$ molecules$^{-2}$ sec$^{-1}$, with an average deviation of 6.5%. The third body was mainly argon.

# PHOTOCHEMISTRY
# RADIATION CHEMISTRY

541.14

1922. EVALUATION OF QUANTUM YIELDS FOR POLYMER CROSSLINKING AND SCISSION BY LIGHT. A.R.Shultz.
J. chem. Phys., Vol. 29, No. 1, 200-6 (July, 1958).

Elementary mathematical relations are formulated to permit calculation of quantum yields for polymer crosslinking and scission by exponentially attenuated radiations. The data required are such readily observable quantities as polymer molecular weight, solution viscosity, insolubles (gel) content, film thickness, radiation absorption coefficient and incident surface radiation dose. The derived equations are illustrated graphically to facilitate visualization of the interplay of the various factors influencing polymer film modification by radiation.

541.14 : 537.312.5

PHOTOCHEMICAL EFFECTS AND THE EFFECT OF OXYGEN ON PHOTOCONDUCTING CADMIUM SULPHIDE CRYSTALS. See Abstr. 1473

541.15

1923. DECOMPOSITION OF HYDROXYLAMINE IN AQUEOUS SOLUTIONS BY GAMMA RADIATION. M.Lefort and X.Tarrago.
C.R. Acad. Sci. (Paris), Vol. 247, No. 4, 454-6 (July 28, 1958).
In French.

When $5 \times 10^{-3}$ M aqueous $NH_2OH$ solutions were exposed to $Co^{60}$ gamma-radiation, the following G values were measured: $-NH_3OH^+ = 6.8 \pm 0.2$, $NH_4^+ = 2.25 \pm 0.1$, $N_2 = 2.0 \pm 0.05$, $H_2N_2O_2 = 0.33 \pm 0.05$, $H_2 = 0.45 \pm 0.2$. In the presence of $O_2$ the decomposition yield was reduced overall, nitrates were formed and nitrites detected as initial products. A reaction scheme is suggested.

M.Ebert

541.15

1924. BOND RUPTURE OF $HBr^{80m}$ FOLLOWING NUCLEAR ISOMERIC TRANSITION. R.H.Luebbe, Jr and J.E.Willard.
J. chem. Phys., Vol. 29, No. 1, 124-7 (July, 1958).

When the $Br^{80m}$ in $HBr^{80m}$ undergoes isomeric transition the $HBr^{80}$ bond is broken in 93% or more of the events rather than only 75% as indicated by earlier work. In gaseous mixtures of HBr, $CH_3Br$, and 1,2-dibromoethylene containing either $HBr^{80m}$ or $CH_3Br^{80m}$, the distribution of the $Br^{80}$ daughter between organic and inorganic combination is dependent upon the $HBr/C_2H_2Br_2$ ratio, indicating that $C_2H_2Br_2$ does not compete as effectively with HBr for the $Br^{80}$ atoms as formerly thought.

541.15

1925. FREE RADICAL FORMATION IN SOLIDS BY ION BOMBARDMENT. H.A.Papazian.
J. chem. Phys., Vol. 29, No. 2, 448-9 (Aug., 1958).

Non-glassy condensates of $HN_3$ are white when deposited on the inside of a cold finger of a vacuum system. When a Tesla coil was discharged against the outer wall of the cold finger for 20 sec a blue coloured spot was produced opposite the tip of the coil (4-5 Mc/s, 50 000 V). A magnetic field of 100 gauss, perpendicular to the line Tesla coil tip–blue spot, split the coloration into two equally intense spots. Increasing field strength reduced the intensity of the colour of the spot caused by negative particles, which disappeared at a field strength of 500 gauss. The time of sparking to produce colour was inversely related to the pressure in the system. It is concluded that the energy of electrons to produce coloration was ≤ 20 kV. Similar qualitative behaviour was observed with deposits of $CH_3OH$ and $CH_3I$.

M.Ebert

# DISPERSIONS . COLLOIDS . ADSORPTION

541.183

1926. INTERACTION OF SINGLE ARGON ATOMS WITH GRAPHITIZED CARBON BLACK P-33 (2700).
G.Constabaris and G.D.Halsey, Jr.
J. chem. Phys., Vol. 27, No. 6, 1433-4 (Dec., 1957).

Argon and the carbon black were introduced into a calibrated adiabatic calorimeter and the apparent volume, extrapolated to zero pressure, determined at five temperatures between 174° and 273°K. Results are in good agreement with the B.E.T. theory.

G.I.W.Llewelyn

541.183 : 539.19

ADIABATIC COOLING BY ADSORBED PARAHYDROGEN. See Abstr. 1820

541.183.2 : 537.311.4

1927. USING CONTACT RESISTANCE TO MEASURE ADSORPTION OF GASES ON METALS. P.Kisliuk.
Bell Syst. tech. J., Vol. 37, No. 4, 925-49 (July, 1958).

The contact resistance between electrodes of molybdenum and tungsten is used to investigate the adsorption of nitrogen and oxygen. It is found that, on clean metals, the initial period of fast adsorption gives rise to a surface resistivity of about $4 \times 10^{-10}$ ohm cm$^2$, corresponding to a layer of the order of 1.6 A thick on each surface. To remove, within a minute or so, the layers resulting from adsorption beyond this initial period, temperatures near 1700°K are required for all four metal–gas combinations. Some of the oxygen adsorbed at a pressure of a few Torr at room temperature can be removed by lowering the pressure, but such an effect was not observed for nitrogen. Nitrogen or oxygen adsorbed during the initial period of fast adsorption on clean molybdenum or tungsten at a temperature of 100°K is not removed in times of the order of one hour by lowering the pressure, in disagreement with some results in the literature. The rate of migration of adsorbed oxygen into and out of the region between closed contacts is found to be much lower than that reported in an earlier experiment of the same type.

# CHEMICAL ANALYSIS

545.8 : 537.534.3

1928. MASS SPECTROMETRIC ANALYSIS OF SOME HYDROGEN OXIDES. I. L.Kerwin and M.Cottin.
Canad. J. Phys., Vol. 36, No. 2, 184-91 (Feb., 1958).

Typical mass spectrograms for $H_2O$, $D_2O$, $H_2O_2$, and $D_2O_2$ are presented. Both positive and negative ions were observed. The variations of the abundances of the spectrogram components with pressure are given. Some features of the experimental data are discussed.

545.827 : 537.543.3 : 533.16

FRACTIONATION OF GAS IN MASS SPECTROMETER ION SOURCE. See Abstr. 1158

545.828 : 550.9

1929. DETERMINATION OF AGE BY THE RUBIDIUM–STRONTIUM METHOD USING SPECTRUM ANALYSIS WITH A VOLTA LUMINESCENCE LIGHT SOURCE. H.Kocher.
Z. angew. Phys., Vol. 10, No. 3, 150-5 (March, 1958). In German.

By passing a controlled current into a solution of electrolytes the arc or spark emission lines may be excited at the cathode and photographed to determine relative abundance of cations. The procedure is described in detail for the Rb/Sr ratio in a Swedish microcline. From this ratio and the content of radioactive $Sr^{87}$, and assuming a value for the half-life of $Rb^{87}$, the age of the mineral was estimated as $2.09 \times 10^9$ years.

S.T.Henderson

# CRYSTALLOGRAPHY

548.5

1930. EFFECT OF POISONS ON CRYSTAL GROWTH.
G.W.Sears.
J. chem. Phys., Vol. 29, No. 5, 1045-8 (Nov., 1958).

The effect of impurities is inexplicable by the accepted theory of crystal growth. In this report a mechanism is presented which describes the specific action of crystal-growth poisons. By this model the step motion in growth is hindered and nucleation rate on an ideal surface is increased. To rationalize the effect of growth poisons it is necessary to postulate that complete monostep adsorption occurs at growth steps. In addition, the poison ion or molecule must present energetic and/or steric barriers to the addition of solute atoms so as to form an unpoisoned step by burying the adsorbed line of molecules.

548.5

1931. METHOD FOR GROWING LARGE CdS AND ZnS SINGLE CRYSTALS. L.C.Greene, D.C.Reynolds, S.J.Czyzak and W.M.Baker.
J. chem. Phys., Vol. 29, No. 6, 1375-80 (Dec., 1958).

A new technique for growing single crystals of CdS and ZnS has been devised in which single crystals up to 115 g in weight are obtained. The conversion of sphalerite into wurtzite,and vice versa,is described. The growth mechanism of the single ZnS crystals is described and compared with that for CdS crystals previously reported.

548.5 : 66.041

FURNACE FOR THE GROWTH OF NAPHTHALENE AND ANTHRACENE CRYSTALS. See Abstr. 974

548.522

1932. MODE OF GROWTH OF ICE CRYSTALS IN AIR AND OTHER GASES. K.Isono.
Nature (London), Vol. 182, 1221-2 (Nov. 1, 1958).

Experiments were carried out designed to study the effects of thermal conductivity of air and rate of diffusion of water vapour in air on the habit of ice crystals. Crystals were grown between 0°C and −16°C in air at low pressures and in hydrogen and other gases at normal pressures. The results indicate that the habit is primarily determined by the high diffusion rate of water through the gases.
B.T.M.Willis

548.523

1933. GROWTH OF POTASSIUM CHLORIDE CRYSTALS FROM AQUEOUS SOLUTION. G.W.Sears.
J. chem. Phys., Vol. 29, No. 5, 979-83 (Nov., 1958).

It is shown that the growth behaviour of potassium chloride crystals from aqueous solution is consistent with the Frank growth mechanism. The growth behaviour is altered by the presence of a few parts per million of lead chloride. It is imputed that the rate of growth at unit steps is inhibited and that the rate of two-dimensional nucleation is markedly increased by the presence of lead chloride. The effects are consistent with complete line adsorption of a complex lead containing ion at growth steps.

548.55

1934. PRODUCTION OF ORIENTED GERMANIUM CRYSTALS BY THE CONTACT METHOD. É.Rubesh.
Zh. tekh. Fiz., Vol. 27, No. 8, 1655-60 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1538-43 (Aug., 1957).

An application of Czochralski's method was developed for producing single crystals and bicrystals of germanium, using a germanium contact, from which crystallization commenced. These crystals are oriented spontaneously in accordance with the temperature field of the apparatus, and are distinguished by well-developed crystal faces.

548.55

1935. CRYSTALLOGRAPHY OF GERMANIUM. G.Novak.
Zh. tekh. Fiz., Vol. 27, No. 8, 1661-70 (1957). In Russian. English translation in: Soviet Physics — Technical Physics (New York), Vol. 2, No. 8, 1544-52 (Aug., 1957).

Goniometric examination has shown the possibility of determining, in a simple and rapid manner, the orientation of germanium crystals from their external morphological features. Based on a study of the crystal structure, an attempt is made to provide an explanation of the tendency of single crystals and bicrystals of germanium to oriented growth in the Rubesh contact method (see preceding abstract).

## X-RAY CRYSTALLOGRAPHY

548.73/.74

X-RAY AND ELECTRON INVESTIGATION OF MATERIALS. See also the Section entitled "STRUCTURE OF SOLIDS".

548.733

1936. A DIFFRACTOMETER FOR ACCURATE X-RAY INTENSITY MEASUREMENTS. U.Korhonen and S.Vihinen.
Ann. Acad. Sci. Fennicae A VI, No. 10, 12 pp. (1958).

An automatically recording X-ray diffractometer (spectrometer) is described. The intensities of the diffraction lines are measured by means of a photomultiplier tube feeding a bridge amplifier and finally an automatic recorder. The diffractometer constructed is of the Bragg—Brentano type in which the specimen, the detector (photomultiplier), and the paper chart of the recorder move synchronously. The accuracy, the reliability and the resolving power of the instrument are discussed. The accuracy proved to be a few tenths of 1%.

548.733

1937. DOUBLE REFLECTION X-RAY CAMERA. B.S.Fraenkel.
Rev. sci. Instrum., Vol. 29, No. 8, 726-7 (Aug., 1958).

An improved camera is described in which both the crystal and the film rotate simultaneously. It registers X-ray reflections from crystals in the form of a line, and shows the double reflections on this line. Some examples of double reflections taken with this apparatus are shown.

548.736.1

1938. EFFECT OF CHEMICAL IMPURITIES ON X-RAY INTEGRATED INTENSITIES IN NEARLY PERFECT GERMANIUM. B.W.Batterman.
Phys. Rev. Letters, Vol. 1, No. 7, 228-9 (Oct. 1, 1958).

The integrated intensities of (111), (333), and (444) reflections were found to be increased by the addition of indium or lithium. The increase is probably due to reduction of primary extinction effect.
A.R.Stokes

548.736.4

1939. THE CRYSTAL STRUCTURE OF $Mo_5SiB_2$. B.Aronsson.
Acta chem. Scand., Vol. 12, No. 1, 31-7 (1958).

The result of an investigation of the Mo-rich corner of the Mo—Si—B system is in accordance with the phase diagram recently given by Nowotny et al. The crystal structure of the ternary phase, $Mo_5SiB_2$, was determined from single crystal data. There is definite evidence for an ordered distribution of the Si and B atoms. The $Mo_5SiB_2$-structure is described and discussed in comparison to similar phases, especially the ternary $Me_5Si_3(X')$-phases of the $D8_8$-type, (X' = B, C, N, O). [This paper was originally presented at the 16th International Congress on Pure and Applied Chemistry, Paris, 1957].

548.736.4 : 538.22

CRYSTALLOGRAPHIC PROPERTIES OF THE SYSTEM $Li_X^+Ni_{1-2X}^{++}Ni_X^{+++}O$. See Abstr. 1582

548.736.5

1940. AN IMPROVED X-RAY METHOD FOR DETERMINING CATION DISTRIBUTION IN FERRITES.
L.P.Skolnick, S.Kondo and L.R.Lavine.
J. appl. Phys., Vol. 29, No. 2, 198-203 (Feb., 1958).

Cation distribution in many ferrites has been difficult to determine by X-ray diffraction since the scattering factors of such cations as Ni, Co, Mn, and Cu are close to that of Fe. By using radiation of a wavelength close to the absorption edge of one of the cations sufficient difference in X-ray scattering factors can be developed because of anomalous dispersion, thus allowing the cation distribution to be ascertained. This method was employed in the case of nickel ferrite. As a modification of Bertaut's technique (Abstr. 6351/1951) ratios of intensities of the diffracted peaks for FeKα and FeKβ radiation from nickel ferrite were used to eliminate certain factors in the intensity equation which are difficult to calculate, for example, the absorption and temperature factors. A least-squares technique was used to determine the best values of the cation distribution and the oxygen position for the intensity ratios obtained for seven reflections. It was found that the cation distribution coefficient was 0.48 ± 0.02, in agreement with the results

obtained by magnetic-moment measurements and neutron diffraction. The oxygen positional parameter was found to be 0.240 ± 0.002 of the lattice parameter with an octahedral position at the origin, which is in good agreement with the value obtained using neutron diffraction. The method appears to be of general value in distinguishing between two elements distributed over non-equilavent positions in a crystal lattice when their X-ray scattering factors are almost equal.

# GEOPHYSICS

550.3 : 539.31

1941. SOME GEOPHYSICAL APPLICATIONS OF THE ELASTICITY THEORY OF DISLOCATIONS. J.A.Steketee.
Canad. J. Phys., Vol. 36, No. 9, 1168-98 (Sept., 1958).

In this paper some aspects of the elasticity theory of dislocations (E.T.D.) which may be of geophysical significance are discussed. The central position of A- and B-nuclei of strain in this theory is emphasized. Applications to cracks and seismological models are indicated. Some limitations of the E.T.D. for applications to geophysics appear in the discussion of strain energy. The displacement field at the surface of a semi-infinite elastic medium which contains a particular B-nucleus at depth c is discussed. Although the considerations in this paper are in several respects incomplete and of a preliminary character, it is expected that the reader may recognize the analogy of the E.T.D. with potential theory and will appreciate the power of the theory to unify several isolated problems on cracks and seismological models and to suggest further applications which are of geophysical interest.

550.38 : 523.5

1942. A SEARCH FOR MAGNETIC EFFECTS FROM METEORS. G.S.Hawkins.
J. geophys. Res., Vol. 63, No. 3, 467-75 (Sept., 1958).

A magnetometer was operated in conjunction with the Super-Schmidt cameras of the Harvard Meteor Project. No magnetic pulses were detected from meteors with visual magnitudes between +5 and −3. The minimum signal detectable with the equipment was $5 \times 10^{-2}$ gamma in the first series of measurements, and was subsequently reduced to $3 \times 10^{-3}$ gamma. This result is in direct contradiction with the work of Kalashnikov (1952), and reasons for the discrepancy are discussed.

550.38

1943. A METHOD FOR ANALYZING VALUES OF THE SCALAR MAGNETIC INTENSITY. A.J.Zmuda.
J. geophys. Res., Vol. 63, No. 3, 477-90 (Sept., 1958).

Various studies on the interaction between charged particles and the geomagnetic field indicate the existence of a source of magnetism located above the earth's surface. It is likely that in the near future, magnetic studies connected with the external source and with upper-air magnetic properties in general, will be conducted primarily with magnetometers measuring only the magnitude of the intensity, not its direction. With this type of data, the customary methods of analysis are not applicable. An appropriate analytic method is treated which utilizes a series for the square of the scalar magnetic intensity. The terms of this series are obtained through the use of the series of spherical harmonics generally applied to each component of the intensity. Through an analysis of scalar intensity alone, the method yields the magnetic characteristics that are normally obtainable through a spherical harmonic analysis of the vector magnetic intensity. Also, the variation with altitude of the magnetic equator is treated in conjunction with the location of the equator for cosmic rays.

550.385 : 523.746

SUNSPOTS AND GEOMAGNETISM. See Abstr. 1000

550.9 : 545.828

DETERMINATION OF AGE BY THE RUBIDIUM–STRONTIUM METHOD. See Abstr. 1929

551.46.018

1944. A TEMPERATURE–CHLORINITY–DEPTH RECORDER FOR USE AT SEA. B.V.Hamon and N.L.Brown.
J. sci. Instrum., Vol. 35, No. 12, 452-8 (Dec., 1958).

An instrument for recording temperature, chlorinity and depth in the upper 1000 m of the sea is described. The temperature range is 0-30°C, with an accuracy of ±0.15 deg C. The chlorinity range spans about seven parts per thousand of chlorinity, the accuracy being ±0.03 parts per thousand. The accuracy in depth is ±10 m. The three quantities are recorded sequentially by a single-pen strip-chart recorder, each quantity being recorded for five seconds at a time. The underwater unit is suspended by means of an armoured steel cable, which has a single electrically-insulated core. This core carries power down to the underwater unit, and brings up the signals from the measuring elements. A simple frequency-modulation method of telemetering is used.

## ATMOSPHERE . IONOSPHERE

551.508.71

1945. A THERMOCOUPLE METHOD FOR MEASURING RELATIVE HUMIDITY IN THE RANGE 95-100%.
J.L.Monteith and P.C.Owen.
J. sci. Instrum., Vol. 35, No. 12, 443-6 (Dec., 1958).

At high relative humidities a current of 30 mA through a 38 s.w.g. chromel-p/constantan thermocouple produces sufficient Peltier cooling to form a film of water on the junction which may then be used as the wet-bulb of a psychrometer. The wet-bulb depression can be read to 0.001°C and in the range 97-100% changes of 0.01% relative humidity can be detected. After calibration over sodium chloride solutions the psychrometer has been used to determine the water content/free energy curves of two soils, and good agreement has been obtained with previous determinations by other methods.

551.510.535

1946. THE MAGNETIC FIELD IN THE F2 LAYER AT DAKAR. K.Suchy and P.Vila.
Ann. Geophys., Vol. 12, No. 4, 277-82 (1956). In French.

The gyrofrequency, fH, at the level of the F2 layer maximum at Dakar was determined from values of the magneto-ionic separation of the critical frequencies. The variation of fH with height agrees fairly well with that expected for the magnetic field of a dipole, and the diurnal and annual variations at a fixed height may also be found. It was found that the deviation of the magneto-ionic components in the magnetic meridian could be neglected for the present case of monthly median values for a station of low dip-angle. G.M.Brown

551.510.535

1947. COMPUTATIONS OF ELECTRON DENSITY DISTRIBUTIONS IN THE IONOSPHERE MAKING FULL ALLOWANCE FOR THE GEOMAGNETIC FIELD. R.A.Duncan.
J. geophys. Res., Vol. 63, No. 3, 491-9 (Sept., 1958).

Jackson's method (J. geophys. Res., Vol. 61, No. 1, 107-28, March, 1956) of computing electron density distributions from h'f records has been modified slightly and adapted for use on an electronic computer. Reduction of a single h'f record takes about 20 sec of computer time. The method makes allowance for the geomagnetic field and is exact save for the uncertainty about the electron density between ionospheric layers which is inherent in the method of pulse sounding from the ground. Rocket measurements enable a reasonable resolution of this uncertainty. Some examples of electron density distribution at Brisbane are given. It is shown that the night-time distributions are much closer to the Chapman than the parabolic form. This is to be expected in a region in which the electron distribution is determined by the opposing processes of downward diffusion under gravity, and a height gradient of electron decay. The effect of geomagnetic disturbance on the day and night electron density profile is illustrated and discussed.

551.510.535

1948. SEQUENTIAL $E_s$ AND LUNAR EFFECTS ON THE EQUATORIAL $E_s$. S.Matsushita.
J. Geomagn. Geoelect., Vol. 7, No. 3, 91-5 (Sept., 1955).

551.510.535

1949. DISTURBANCES IN THE IONOSPHERIC F2 REGION ASSOCIATED WITH GEOMAGNETIC STORMS. I. EQUATORIAL ZONE. T.Sato.
J. Geomagn. Geoelect., Vol. 8, No. 4, 129-35 (Dec., 1956).

Explanation of the ionospheric F2 disturbances on the equatorial zone as the effect of the vertical drift of the electrons caused by the electric field associated with the disturbance-daily variation of the earth's magnetic field. The geomagnetic and the ionospheric data are those of Huancayo on the magnetic equator. The disturbed variations are calculated for the individual ionospheric disturbances. The results show that the calculated variations of the disturbances agree well with the observed ionospheric data, both in the magnitudes and in the characteristics of the variations.

551.510.535

1950. DISTURBANCES IN THE IONOSPHERIC F2 REGION ASSOCIATED WITH GEOMAGNETIC STORMS. II. MIDDLE LATITUDES. T.Sato.
J. Geomagn. Geoelect., Vol. 9, No. 1, 1-22 (March, 1957).

It is shown that in middle latitudes the variations of $f_oF2$ on the storm day can be classified in two types: negative and positive disturbances. The vertical drift of the electrons is considered to be caused by an electric field associated with the disturbance-daily variation of the geomagnetic field. The results of the calculations for individual states show that the two types of disturbance in the middle latitudes can be explained as an effect of the vertical drift of electrons. It is found that the occurrence of the positive or negative disturbances is due to the fact that the phase of the drift velocity of the electrons on a quiet day is the same as that of the drift velocity on a disturbed day (negative), or that the phase of the former differs from that of the latter by about 180° (positive). It is also found that the seasonal and latitudinal variations of the F2 disturbance are due to the existence of the $S_q$ dynamo current in the ionosphere.

551.510.535

1951. DISTURBANCES IN THE IONOSPHERIC F2 REGION ASSOCIATED WITH GEOMAGNETIC STORMS. III. AURORAL LATITUDES. T.Sato.
J. Geomagn. Geoelect., Vol. 9, No. 2, 94-106 (1957).

The results of this study show that F2 disturbances in the auroral latitudes, as well as those in lower ones, are due to the effect of the vertical drift of electrons caused by the electric field associated with the geomagnetic disturbance daily variation.

551.510.535

1952. HORIZONTAL WIND SYSTEMS IN THE IONOSPHERIC E REGION DEDUCED FROM THE DYNAMO THEORY OF THE GEOMAGNETIC $S_q$ VARIATION. I. NON-ROTATING EARTH. H.Maeda.
J. Geomagn. Geoelect., Vol. 7, No. 4, 121-32 (Dec., 1955).

It is found that the main harmonic term of the wind velocities necessary to produce quiet-day magnetic variations is not semi-diurnal, but diurnal. The diurnal amplitude is about 30 m/sec and the semi-diurnal one about 10 m/sec at low latitudes. The semi-dirunal component is nearly in phase with that of winds on the ground (derived from the barometric pressure variation), and its tidal amplification is estimated as about 50. The vertical drift velocities of electrons in the F-region are estimated.

551.510.535

1953. HORIZONTAL WIND SYSTEMS IN THE IONOSPHERIC E REGION DEDUCED FROM THE DYNAMO THEORY OF THE GEOMAGNETIC $S_q$ VARIATION. II. ROTATING EARTH. S.Kato.
J. Geomagn. Geoelect., Vol. 8, No. 1, 24-37 (March, 1956).

The effect of the Coriolis force is taken into consideration. The wind velocity is obtained by solving the equation of motion of the atmosphere for the rotating earth simultaneously with the dynamo equation. It is shown that the diurnal wind motion predominates over the semi-diurnal one in the E region, and that the semi-diurnal pressure variation is almost in phase with that observed at the ground. The conspicious differences in the results between Pt I and II are considered, and the vertical drift velocity in the F2 region is calculated.

551.510.535

1954. HORIZONTAL WIND SYSTEMS IN THE IONOSPHERIC E REGION DEDUCED FROM THE DYNAMO THEORY OF THE GEOMAGNETIC $S_q$ VARIATION. III. H.Maeda.
J. Geomagn. Geoelect., Vol. 9, No. 2, 86-93 (1957).

Wind systems in the summer and winter hemispheres are deduced from $S_q$ data. A comparison between theoretical results and observed ionospheric winds is made.

551.510.535

1955. HORIZONTAL WIND SYSTEMS IN THE IONOSPHERIC E REGION DEDUCED FROM THE DYNAMO THEORY OF THE GEOMAGNETIC $S_q$ VARIATION. IV. S.Kato.
J. Geomagn. Geoelect., Vol. 9, No. 2, 107-15 (1957).

Wind systems on both northern and southern hemispheres in the solstice season are obtained. The effect of the Coriolis force is taken into account. It is shown (as in Pt III) that in summer the diurnal wind motion is predominant over the semi-diurnal, whereas in winter the velocity of the former is almost the same as that of the latter. Further, the diurnal wind velocity is greater in summer than in winter; but the semi-diurnal wind velocity is somewhat smaller in summer than in winter.

551.510.535

1956. [HORIZONTAL] WIND SYSTEMS [IN THE E-REGION] FOR THE GEOMAGNETIC $S_q$ FIELD. H.Maeda.
J. Geomagn. Geoelect., Vol. 9, No. 2, 119-21 (1957).

551.510.535

RADIO-WAVE PROPAGATION IN THE IONOSPHERE. See also the Section entitled "ELECTROMAGNETIC WAVES AND OSCILLATIONS".

551.521.3 : 535.33.07

1957. DESIGN OF A DOUBLE SPECTROGRAPH FOR THE STUDY OF THE ULTRAVIOLET SPECTRUM OF SKY. J.Lenoble.
Ann. Geophys., Vol. 12, No. 4, 287-9 (1956). In French.

A double spectrograph which gives a good spectrum between 3200 and 4000 A is described and an example presented.

G.I.W.Llewelyn

551.521.3 : 535.345

EFFECT OF FIELD OF VIEW ON MEASUREMENT OF ATMOSPHERIC TRANSMISSION. See Abstr. 1299

551.521.326

1958. ROCKET MEASUREMENTS OF THE NIGHT AIRGLOW. R.Tousey.
Ann. Geophys., Vol. 14, No. 2, 186-95 (1958).

Direct measurements of the altitude of the night airglow conducted from rockets are reviewed. The maximum of the 5577 A layer was found to lie near 98 km: the sodium layer peaks from three flights were 85, 93 and 95 km. An ultraviolet airglow in the region from 2600 to 2900 A (presumed to be $O_2$ radiation in the Herzberg bands) was observed with distribution similar to the 5577 A layer. Some data were obtained for the continuum, certain OH bands, and the 6300 A line of oxygen, but these results are less clear-cut.

551.521.326 : 535.33

1959. OBSERVATION OF A NEW TWILIGHT ATMOSPHERIC EMISSION LINE. J.Delannoy and G.Weill.
C.R. Acad. Sci. (Paris), Vol. 247, No. 11, 806-7 (Sept. 15, 1958). In French.

Twilight spectra photographed in Adelie Land, Antarctica, in course of the International Geophysical Year research programme, reveal a new emission line at 6708 ± 1.5 A, tentatively identified with the resonance line of neutral Li at 6707.84 A. D.R.Barber

551.521.326 : 535.33

1960. THE NEW TWILIGHT LINE.
D.Barbier, J.Delannoy and G.Weill.
C.R. Acad. Sci. (Paris), Vol. 247, No. 12, 886-8 (Sept. 22, 1958). In French.

If the newly-discovered atmospheric emission line at 6708 A (see preceding abstract) is emitted by neutral Li, the observed intensity of the line relative to the $D_2$ line of Na, namely 1 : 8, leads to a value of $7.8 \times 10^{-3}$ for the ratio of the number of Li atoms relative to Na atoms in the upper atmosphere. This value is too large (by a factor ~ 300) to fit Bernard's suggested terrestrial origin of atmospheric Na. A much better agreement is found if a meteoritic origin is invoked (for meteorites, $N(Li)/N(Na) = \sim 2 \times 10^{-3}$).

D.R.Barber

551.521.6

1961. NEAR INFRARED SOLAR RADIATION MEASUREMENTS BY BALLOON TO AN ALTITUDE OF 100 000 FEET.
D.M.Gates, D.G.Murcray, C.C.Shaw and R.J.Herbold.
J. Opt. Soc. Amer., Vol. 48, No. 12, 1010-16 (Dec., 1958).

The first recordings of the near infrared solar spectrum from high altitudes were made by an infrared spectrograph carried to an altitude of 102 000 feet by a skyhook plastic balloon on June 22, 1955, between 0559 and 0830 MST. The total absorption in the 1.9 micron

water vapour absorption band and in the 2.0 micron carbon dioxide absorption band was measured as a function of altitude. The amount of absorbing constituent above each level was determined. Some indication of the pressure dependence of the carbon dioxide absorption is determined. A comparison is made with other water vapour measurements in the atmosphere. A description of the infrared spectrograph, the recording equipment, and of the biaxial pointing control is given.

551.579.5.08

1962. A REVIEW ON METHODS FOR SOIL MOISTURE ESTIMATION " IN SITU". N.Ahmad and M.Saleem.
Pakistan J. Sci., Vol. 10, No. 3, 137-42 (May, 1958).

551.594.14

1963. ELECTRICAL ATMOSPHERIC EFFECTS OF ARTIFICIAL RADIOACTIVITY. H.Israël.
Z. Phys., Vol. 151, No. 1, 35-45 (1958). In German.

In order to examine the question of whether the increase in artificial radioactivity resulting from atomic bomb explosions can influence the electrical conditions of the atmosphere, the ionizing effects of fission products were compared with those of natural ionizing agents in the atmosphere. It appears that airborne fission products have not so far been able to modify the electrical state of the atmosphere. However, close to the ground, effects are possible upon the atmospheric electric field and conductivity with high precipitation activity and especially with dry fall-out. Up to now there is not reason for changes in the duration of electrical atmospheric conditions due to the radioactive content of the air.

C.G.Morgan

551.594.5

1964. SOME OBSERVATIONS OF AURORA USING A LOW-POWER FREQUENCY-MODULATED RADAR. C.Collins.
Canad. J. Phys., Vol. 36, No. 7, 926-34 (July, 1958).

A frequency-modulated, continuous-wave radar is particularly well suited to the observation of auroral ionization, since it provides both range information and a Doppler indication of radial motion. The system parameters of an experimental equipment are briefly considered, and the radar observations are compared with similar measurements made with higher-powered pulse systems.

551.594.5

1965. THE GEOMETRY OF AURORAL IONIZATION. R.S.Unwin.
J. geophys. Res., Vol. 63, No. 3, 501-6 (Sept., 1958).

New evidence is presented which shows that v.h.f. radio echoes from auroral ionization are reflections from aspect-sensitive columns aligned with the earth's magnetic field. Previous experimental data, interpreted in terms of a distribution of ionization along a line of magnetic latitude, are shown to be consistent with this hypothesis.

551.594.5

1966. V.H.F. OBSERVATIONS ON THE AURORA AUSTRALIS. T.J.Seed.
J. geophys. Res., Vol. 63, No. 3, 517-26 (Sept., 1958).

Investigation of the aurora australis at 69 Mc/s is reported. A value for the range exponent in the radar equation was determined and values of the reflection coefficient deduced. Mechanisms of auroral reflection of radio waves are discussed, and only those involving column models are found to be substantiated. Noise emission from auroral ionization was observed and measured at 69 Mc/s.

551.594.51 : 535.332

1967. ON THE PROFILES OF HYDROGEN LINES IN AURORAL SPECTRA. Yu.I.Gal'perin.
Astron. Zh., Vol. 35, No. 3, 382-9 (1958). In Russian.

Published and new data are analysed. It is shown that $H_\alpha$ profiles indicate the penetration of a considerable number of protons with incident velocities of the order of 1000-2000 km/sec. It is thought that such particles cause high-altitude auroral luminescence.

S.Chomet

551.594.6 : 538.566.3

POLARIZATION OF ATMOSPHERIC PULSES DUE TO SUCCESSIVE REFLECTIONS FROM THE IONOSPHERE.
See Abstr. 1633

# BIOPHYSICS
# PHYSIOLOGICAL PHYSICS

591.485 : 599.324.7

1968. EFFECTS OF LOCALIZED HYPOXIA ON THE ELECTROPHYSIOLOGICAL ACTIVITY OF COCHLEA OF THE GUINEA PIG. G.A.Misrahy, B.R. De Jonge, E.W.Shinabarger and J.E.Arnold.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 705-9 (Aug., 1958).

612.72

1969. OPTICAL SPACE PERCEPTION. N.Günther.
Optik, Vol. 15, No. 2-3, 107-10 (Feb.-March, 1958). In German.

One obtains physiological information from one's physical environment and from this one's consciousness derives its psychological conception of space. In addition to this dualistic world there is a third spatial form derived from one's existing picture of the physical world. The interrelation of the visual parts of these spaces is discussed.

E.A.Mussett

612.841

1970. ACCOMMODATION IN THE EYE A COMPENSATION FOR EXISTING ASTIGMATISM? K.Mütze.
Optik, Vol. 15, No. 2-3, 98-106 (Feb.-March, 1958). In German.

Results obtained from measurements on 20 human subjects (40 eyes) suggest that astigmatism normally present is often compensated by that introduced by the act of accommodation.

E.A.Mussett

612.841

1971. STUDY OF THE RELATIONS BETWEEN ACCOMMODATION, CONVERGENCE AND FUSION. G.Weber.
Optik, Vol. 15, No. 8, 474-80 (Aug., 1958). In German.

Measurements were made on 3 human subjects to determine the relative convergence (i.e. convergence with constant accommodation) field of the eyes. The results showed, inter alia, that this depended upon the accommodation and the heterophoria, and that the convergence region of the relative convergence field was greater than the divergence region.

E.A.Mussett

612.842

1972. SIGNIFICANCE OF FLUCTUATIONS OF ACCOMMODATION. F.W.Campbell, G.Westheimer and J.G.Robson.
J. Opt. Soc. Amer., Vol. 48, No. 9, 669 (Sept., 1958).

The slow and fast components of involuntary accommodation oscillations are considered from the point of view of servomechanisms.

R.A.Weale

612.843

1973. RETINAL LIGHT DISTRIBUTION FOR CIRCULAR APERTURES IN MAXWELLIAN VIEW. G.Westheimer.
J. Opt. Soc. Amer., Vol. 49, No. 1, 41-4 (Jan., 1959).

The effect of size of pupil of the eye upon the intensity distributions in retinal images of circular apertures observed in Maxwellian view is treated theoretically. Diffraction images of a small source of light are formed in the pupil and are governed by circular apertures whose angular diameters are of the order of minutes of arc. Quantitative data are presented to illustrate the manner in which sharpness of the retinal image of the aperture is increased by increasing the number of diffraction rings that are admitted to the eye. Amplitude and intensity distributions are included for a given diameter of aperture together with various sizes of pupil (including some annular pupils), and for various diameters of aperture together with one size of pupil. Equations are presented for calculating intensity distributions as modified by the Stiles–Crawford effect or by the effect of defocused eyes.

612.843.3

1974. IDENTIFICATION OF SIGNAL LIGHTS. I. BLUE, GREEN, WHITE, AND PURPLE. R.M.Halsey.
J. Opt. Soc. Amer., Vol. 49, No. 1, 45-55 (Jan., 1959).

One hundred observers identified by name fifty blue, green, white, and purple test colours. Small areas and low illuminances were used to simulate conditions under which signal lights must be

recognized. The results are expressed as chromaticity zones within which the test colours were assigned a given colour name with various degress of certainty. Large individual differences in colour naming were found. Variability due to intensity and viewing distance is also demonstrated. The data can be applied to the specification of boundaries for coloured signals.

612.843.613

1975. DIFFERENCE THRESHOLDS FOR INTERMITTENT PHOTIC STIMULI AS A FUNCTION OF RATE OF FLASH, NUMBER OF FLASHES, AND PRESENTATION TIME. C.R.Brown.
J. Opt. Soc. Amer., Vol. 49, No. 1, 56-60 (Jan., 1959).

Data were obtained on the difference threshold function for intermittent photic stimuli with the method of single stimuli. Combinations of rate of presentation (F), number of flashes in a train (N), and duration of a train (T) were selected to permit plotting difference thresholds as a function of all possible combinations of F, N, and T. The major findings of this study were as follows: (1) The number of flashes in a train has a negligible effect upon the difference threshold either in terms of $\Delta P$ or $\Delta F$. Values of N ranged from 5 to 40 flashes. (2) The duration of a train has a negligible effect upon the difference threshold either in terms of $\Delta P$ or $\Delta F$. Values of T ranged from $\frac{1}{2}$ to 4 sec. (3) The difference threshold function for intermittent photic stimuli obtained with the method of single stimuli is comparable in form to the function obtained with the method of adjustment. (4) Expressing difference thresholds in terms of a period measure points up the similarity between the difference threshold functions obtained with intermittent photic and electric stimuli.

612.85

1976. ON AX AND ABX LIMENS. J.R.Pierce and E.N.Gilbert.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 593-5 (July, 1958).

Rosenblith and Stevens (Abstr. 952/1954) obtained a larger frequency limen by the ABX method than by the AX method. The ratio of the limens is here calculated on the assumption that there is a statistical variation in the physiological or psychological response to a given stimulus. The ratio of limens is 2.12 for a Gaussian distribution of response and 2.14 for a uniform distribution. The model fits data for subject KNS well, but not the data for subject WAR.

612.85

1977. INTELLIGIBILITY OF SELECTED MESSAGE-SETS.
I.Pollack, L.R.Decker and H.Rubenstein.
J. Acoust. Soc. Amer., Vol. 30, No. 7, 643 (July, 1958).

Four message-sets were constructed on the basis of phonemic confusion patterns with the aim of modifying the role of frequency-of-occurrence in the determination of speech intelligibility in noise. Deliberate selection of words may reinforce, nullify or negate word-frequency effects for known message-sets.

612.85

1978. CHANGES IN COCHLEAR ENDOLYMPHATIC OXYGEN AVAILABILITY, ACTION POTENTIAL, AND MICROPHONICS DURING AND FOLLOWING ASPHYXIA, HYPOXIA, AND EXPOSURE TO LOUD SOUNDS.
G.A.Misrahy, E.W.Shinabarger and J.E.Arnold.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 701-4 (Aug., 1958).

612.85

1979. INTENSITY AND DURATION OF NOISE EXPOSURE AND TEMPORARY THRESHOLD SHIFTS. W.Spieth and W.J.Trittipoe.
J. Acoust. Soc. Amer., Vol. 30, No. 8, 710-13 (Aug., 1958).

What is the "trading relationship" between intensity and duration of exposures to loud sound in producing a given magnitude of temporary threshold shift (TTS)? Examination of the literature led to the hypothesis that duration is about twice as important as intensity: Two exposures should produce the same TTS if one exposure were one-fourth the sound level (6 dB less) and twice the duration of the other exposure. The hypothesis was tested on 12 human ears with thermal noise exposures ranging from 130 dB SPL for 1 min to 94 dB SPL for 64 min. In this series each doubling of duration was associated with a fourfold or 6 dB decrease in sound level. TTS was measured at 2000, 4000, 6000, and 8000 c/s. If the hypothesis were true, all exposures should have produced the same TTS. Actually the obtained average TTS, 5 min after exposure, described an inverted U-shaped function when plotted by increasing duration of exposure. The conditions from 118 dB for 4 min through 100 dB for 32 min produced roughly similar amounts of TTS, while the other conditions produced substantially less TTS. The shapes of the recovery curves differed systematically: At 4000 c/s, the TTS's 20 sec after exposure were in perfect rank-order agreement with intensity of exposure, while from about 2 min to 10 min the inverted-U rank order was apparent.

612.85 : 534.831

1980. INTENSIVE DETERMINANTS OF REMOTE MASKING.
R.C.Bilger.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 817-24 (Sept., 1958).

The phenomenon of remote masking, in which a high-frequency band of noise masks tones that are below and remote from the lower cutoff frequency of the band of noise, can be observed when the band of noise exceeds 80 dB SPL. Five experiments were conducted to determine those aspects of a masking noise for which remote masking is invariant. The relative contributions of spectrum level and band-width to remote masking can be described by the general equation $L_R = 2L_S + L_f + C$, where $L_R$ is remote masking in dB; $L_S$ is spectrum level in dB, the SPL of a 1 c/s band-width; and $L_f$ is band-width level in dB based on 1 c/s band-width. The constant is specific to each group of subjects. For remote masking less than 30 dB, the formula does not predict remote masking, but does enable one to equate different conditions of spectrum level and band-width. This equation does not hold as well when frequencies above 4000 c/s are included in the masking noise. The possible causes of this inconsistency are discussed. See also following abstract.

612.85 : 534.831

1981. BINAURAL EFFECTS IN REMOTE MASKING.
I.J.Hirsh and M.Burgeat.
J. Acoust. Soc. Amer., Vol. 30, No. 9, 827-32 (Sept., 1958).

See preceding abstract. The dependence of binaural masked thresholds on the interaural phase relations of both the signal tone and the noise was demonstrated in previous studies, and was repeated here for a wide band of noise (200-4000 c/s). A second experiment was carried out to test whether this dependence extended to the remote masking of low-frequency tones by a high-frequency band of noise (2000-4000 c/s). The results indicate that a phase reversal of the tone at the two ears has the same effect in remote masking as in ordinary masking; but a phase reversal of the high-frequency band at the two ears produces changes in the masked threshold midway between those encountered in ordinary masking and no change at all. The results are interpreted as indicating that the interaural time relations between the remote-masking sources that result from a phase reversal of the high-frequency band involve a time shift of about one half-period of the band midfrequency and a decrease in the interaural correlation.

612.85

1982. PREDICTION OF SPEECH INTELLIGIBILITY AT HIGH NOISE LEVELS. J.M.Pickett and I.Pollack.
J. Acoust. Soc. Amer., Vol. 30, No. 10, 955-63 (Oct., 1958).

612.88

1983. FUNNELING IN THE NERVOUS SYSTEM AND ITS ROLE IN LOUDNESS AND SENSATION INTENSITY ON THE SKIN.
G.v.Békésy.
J. Acoust. Soc. Amer., Vol. 30, No. 5, 399-412 (May, 1958).

615.779

1984. EFFECT OF THE GROWTH-PROMOTING ZONE ON THE DISTRIBUTION OF AN ANTIBIOTIC IN A DIFFUSION TEST.
F.Barnetzky.
Z. angew. Phys., Vol. 10, No. 6, 264-8 (June, 1958). In German.

An attempt at estimating by mathematical analysis the amounts of antibiotics which cause the promotion of bacterial growth at the edge of the growth-inhibition zone, as observed by Rehm (Naturwissenschaften, Vol. 43, 183 (1956); Zentralblatt für Bakteriologie I, Vol. 170, 628, 1958). The distribution of concentrations of antibiotics in the inhibition zone, and the amounts of antibiotics that diffuse across the boundary of that zone, are calculated for both the axial and the axisymmetric radial cases. F.Lachman

616-001.2

1985. HEALTH HAZARDS FROM FISSION PRODUCTS AND FALLOUT. I. PRODUCTS OF INSTANTANEOUS FISSION OF $U^{235}$ WITH THERMAL NEUTRONS. K.Löw and R.Björnerstedt.
Ark. Fys., Vol. 13, Paper 7, 85-90 (1957).

Calculations are made, and the results presented graphically, of the variation with time of the activity of the fission product mixture resulting from the fission of $U^{235}$ with thermal neutrons. To a first approximation this can be considered representative of fallout activity arising from other nuclides. A curve of the variation of total beta activity of the mixture of fission products arising from $U^{235}$ is also given. H.Miller

618.2

1986. MEASUREMENT OF UTERINE FORCES IN OBSTETRICAL LABOR. T.I.Marx and C.A.Hunter, Jr.
Rev. sci. Instrum., Vol. 29, No. 7, 585-7 (July, 1958).

An electronic spherometer is described. The transducer, which is taped to the surface of the abdomen, senses change in the radius of curvature of the uterus, and sends a signal from a strain-gauge bridge through an amplifier-detector to a recorder. The instrument was used to analyse muscular coordination of normal and abnormal labour.

# TECHNIQUE . MATERIALS

621.762 : 537.311.33

1987. SINTERING METHOD FOR SEMICONDUCTOR MATERIAL. G.K.Gaulé, J.T.Breslin and J.R.Pastore.
Rev. sci. Instrum., Vol. 29, No. 7, 565-7 (July, 1958).

The process makes possible the utilization of semiconductor material which comes in the form of small grains or small dendrite-like pieces. When pressure, alternating current, and an r.f. field are applied, this loose material is sintered into rods without using a binder. These rods are used as "feed" for a floating zone apparatus.

669

1988. THE PREPARATION OF SINGLE-CRYSTAL INGOTS OF SILICON BY THE PULLING TECHNIQUE.
E.Billig and D.B.Gasson.
J. sci. Instrum., Vol. 35, No. 10, 360-5 (Oct., 1958).

The construction and operation of a laboratory furnace for preparing monocrystals of silicon by the pulling technique are described. The design allows for close observation of the growth front of the ingot during its preparation. It has been found possible to assess the quality of high-grade silicon, and also to obtain an indication of the concentration of dominant impurities responsible for the measured resistivity by comparison with computed distribution curves.

669.054 : 537.311.33

1989. PRODUCTION OF INDIUM ANTIMONIDE OF A HIGH DEGREE OF PURITY BY ZONE REFINING.
K.I.Vinogradova, V.V.Galavanov and D.N.Nasledov.
Zh. tekh. Fiz., Vol. 27, No. 9, 1976-84 (1957). In Russian.

The present article gives the results of work on the purification of indium antimonide by the method of zone refining. For checking the purity of different specimens the distribution was measured, along the specimen, of the electrical conductivity, impurity concentration and mobility of current carriers. The minimum impurity concentration was $2.5 \times 10^{13}$ cm$^{-3}$. Maximum current carrier mobility was $4 \times 10^5$ cm$^2$/V sec at 77°K and about $10^5$ cm$^2$/V sec at room temperature.

669.09

1990. PREPARATION OF POLYCRYSTALLINE FERRIMAGNETIC GARNET MATERIALS FOR MICROWAVE APPLICATIONS.
W.P.Wolf and G.P.Rodrigue.
J. appl. Phys., Vol. 29, No. 1, 105-8 (Jan., 1958).

A simple chemical method is described for preparing high density, polycrystalline, magnetic garnets suitable for microwave applications, having the formula $3M_2O_3 \cdot 5Fe_2O_3$, where M is a rare earth from Sm to Lu, or yttrium. The effect on the dielectric loss of small deviations from the ideal M : Fe composition was investigated, and it was found that, in contrast to ferrites having the spinel structure a small deficiency of iron gives rise to a considerable increase in the loss. The loss tangents for stoichiometric samples were of the order of 0.002 at 20 Mc/s. The effect of porosity on the ferrimagnetic resonance line width was investigated in several samples of the yttrium garnet and it was found that the observed variation could be accounted for almost entirely by Schlömann's theory of pore broadening, with only a small contribution from anisotropy. The narrowest line observed at room temperature, on a sample having 96% of the theoretical X-ray density, was 50 Oe. The trend of the results indicated that a 100% dense sample should have a line width of about one-half this value.

## PHOTOGRAPHY

77.0

1991. DETERMINATION OF THE FOURIER SPECTRA OF PHOTOGRAPHIC IMAGES. J.C.Viénot.
Proc. Phys. Soc., Vol. 72, Pt 4, 661-72 (Oct., 1958).

The determination of the spatial frequency density in the image recorded by a film or a photographic plate is shown to be possible by the measure of the total flux transmitted when the film or plate is illuminated by a sinusoidal distribution of light superposed on the transparency. The sinusoidal light distribution is produced in the form of two-beam interference fringes. In the present instrument fringes of good contrast are obtainable at frequencies greater than 20 per millimetre. The apparatus has been used to determine the frequency spectra of slits, a line-grating and of different scenes taken by air photography.

771.3

1992. HIGH-SPEED FRAMING DISK CAMERA. C.H.Bagley.
Rev. sci. Instrum., Vol. 29, No. 10, 862-4 (Oct., 1958).

A high-speed framing camera designed to investigate problems requiring a time coverage of from 6 to 20 msec. Sixty picures at framing rates up to 15 000 frames/sec are possible. Unique to this system are the large image size ($\frac{8}{8} \times 1\frac{1}{4}$ in. or $\frac{3}{8} \times 1\frac{1}{4}$ in. depending on the framing rate required), and the very short exposure times (0.2 $\mu$sec). The short exposure time has made this instrument useful in a number of applications.

778.34 : 539.1.07

1993. THE LOADING OF NUCLEAR EMULSION WITH PHOSPHORS BY MEANS OF ABSORPTION. G.Mayr.
Ricerca sci., Vol. 28, No. 6, 1205-10 (June, 1958). In Italian.

With the help of experimental data presented in a previous paper (Abstr. 7642/1958), the conditions required to obtain the maximum yield in loading nuclear emulsions with phosphors were investigated. This ensures a satisfactory photographic response.
G.Martelli

778.37 : 534.222.2

CYLINDRICAL SHOCK WAVES FROM EXPLODING WIRE. ROTATING-MIRROR TECHNIQUE. See Abstr. 1196

778.6

1994. A COLOR "ELECTROFAX" PROCESS.
J.S.Rydz and S.W.Johnson.
R.C.A. Rev., Vol. 19, No. 3, 465-86 (Sept., 1958).

Electrofax colour prints, while similar in appearance to photographic results, do not follow the subtractive colour mixture laws which describe dye images. The basic principles of pigment mixtures and the application of the Kubelka analysis to the Electrofax colour process are discussed. Colorimetric data for the printing of Electrofax particles is presented. A method of separating colour for producing line work is discussed. The method differs from the conventional techniques of using tri-colour filters in that the separation of colour is achieved by controlling the amount of exposure on a scene. The mixing of colours, which occurs due to the fusing operation in the Electrofax process, provides the potential means for a colour print system based on particle mixing rather than overlaying dyes as in a halftone printing ink process.

# LIST OF JOURNALS

The following list supplements the List of Journals published with the Index to Volume 61 (1958). Reprints of the List of Journals can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s.0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

| | |
|---|---|
| Elettronica | Elettronica<br>Via Arsenale 21, Turin. |
| Japan. J. Geophys. | Japanese Journal of Geophysics.<br>Science Council of Japan, Ueno Park, Tokyo. |
| Rep. Inst. High Speed Mech., Tohoku Univ. | Reports of the Institute of High Speed Mechanics, Tôhoku University.<br>[A section of Science Reports of the Research Institutes, Tôhoku University, Series B (Technology)]. Tôhoku University, Sendai. |
| Sci. Pap. Inst. Phys. Chem. Res. (Tokyo) | Scientific Papers of the Institute of Physical and Chemical Research. (Formerly: Journal of the Scientific Research Institute).<br>Institute of Physical and Chemical Research, Komagome, Bunkyo-ku, Tokyo. |
| Tech.-wiss. Abhandl. Osram-Gesell. | Technisch-wissenschaftliche Abhandlungen der Osram-Gesellschaft.<br>Springer-Verlag, Berlin, Göttingen and Heidelberg. |
| Textile res. J. | Textile Research Journal.<br>Publications Department, P.O.Box 625, Princeton, New Jersey. |
| Trans Plastics Inst. | Transactions of the Plastics Institute.<br>4 Mandeville Place, London, W.1. |
| Votre Electricite | Votre électricité. Bulletin Bimestriel de l'Union des Exploitations Electriques en Belgique.<br>7 Cantersteen, Galerie Ravenstein 4, Brussels.<br>(Formerly referenced as: Bull. Un. Exploit. Elect. Belgique). |

NOTES

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|---|---|
| Bull. Un. Exploit. Elect. Belgique | Bulletin Bimestriel de l'Union des Exploitations Electriques en Belgique.<br>Now referenced as: Votre Electricite. |
| Ingegnere | Ingegnere<br>Address changed to: Via della Mercede 33, Rome. |
| J. Sci. Res. Inst. (Tokyo) | Journal of the Scientific Research Institute.<br>Title changed to: Scientific Papers of the Institute of Physical and Chemical Research [Sci. Pap. Inst. Phys. Chem. Res. (Tokyo)] with Vol. 52, Nos. 1486-1491, Sept., 1958. |

# ERRATA

January, 1959, Abstr. 41, line 3 : for "In Spanish" read "In Portuguese".

Annual Index (1958), List of Journals.

After the entry "Acta polytech." insert the following amended entry:

Acta polytech. Scand.
Acta Polytechnica Scandinavica. (Formerly: Acta Polytechnica). — Scandinavian Council for Applied Research. Publication address: P.O.Box 5073, Stockholm 5. (The monographs in the new sub-series which started in 1958 are numbered as follows: Electrical Engineering, El; Mathematics and Computing Machinery, Ma; Physics, including Nucleonics, Ph.)

After the entry "Automatica si Electronica" insert the following amended entry:

Avhandl. Norske VidenskAkad. Oslo
Avhandlingar utgitt av Det Norske Videnskaps-Akademi i Oslo.
I. Matematisk-Naturvidenskaplige Klasse. — Faculty of Mathematics and Science, University of Oslo, Blindern, per Oslo.

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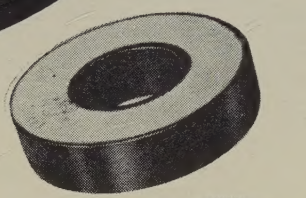

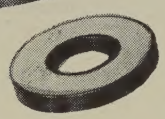

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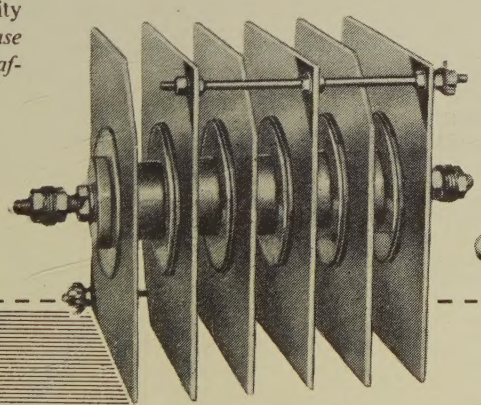

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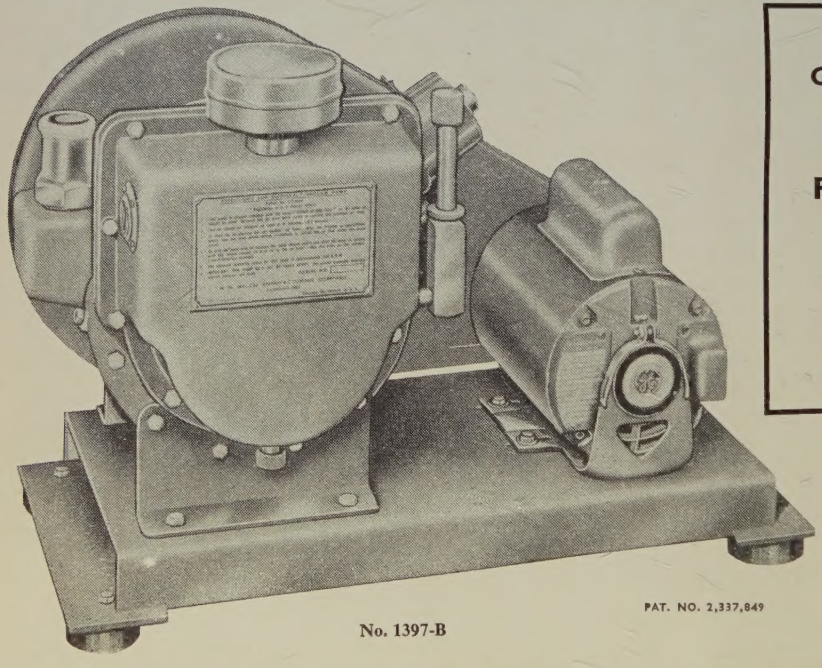

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375 Litres Per Minute

**Ideal for backing-up Diffusion Pumps**

The Welch vented exhaust pump has provision for adjusting the amount of air introduced to meet various conditions of temperature and vapor concentration. The design is such that the air admitted through the exhaust vent cannot return to the system, so ultimate vacuum attainable approaches that of the same pump with the exhaust vent closed.

Thus the vented exhaust enables these Duo-Seal pumps to remove both permanent and condensable gases from a system without contamination of the oil. This means in practice that these pumps will be able to reach lower total pressures in shorter periods of time, and good vacuum performance will be possible for long periods without the bothersome trapping and excessive number of oil changes formerly necessary.

**1397B. DUO-SEAL VACUUM PUMP, Motor Driven.**
For 115 Volts, 60 Cycles, A.C. Each $625.00

**1397C. DUO-SEAL VACUUM PUMP, Motor Driven.**
For 230 Volts, 60 Cycles, A.C. Each $625.0

**1397D. DUO-SEAL VACUUM PUMP, Motor Driven.**
For 115 Volts, D.C. Each $697.50

*A belt guard is included with the mounted pumps.*

**1397. DUO-SEAL VACUUM PUMP, Unmounted.**
With pulley, but without motor, belt or base.
Each, $500·25

**Pump Revolutions - 300 RPM**
**Motor - ¾ HP - 1725 RPM**
**Tubing Required - 1⅝-inch i.d.**
**Over-all Dimensions of Mounted Pump**
**25⅝ × 14¾ × 18¾ inches high**
**Belt-tightening Provision**
**Extra Supply of Duo-Seal Oil**

## W. M. WELCH SCIENTIFIC COMPANY

DIVISION OF W. M. WELCH MANUFACTURING COMPANY

**Established 1880**

**1515 Sedgwick St. Dept. PA. Chicago 10, Ill. U.S.A.**

*Manufacturers of Scientific Instruments and Laboratory Apparatus.*

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